Power Engineering

DECEMBER 1960

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Now...new from Bailey

...a "foolproof"

FLAME DETECTOR

that rejects flames from other burners

Flame detectors are sometimes "fooled" by glowing refractories or flames from burners adjacent to that under surveillance. This new Bailey Flame Detector *responds only to the flame it surveys* . . . assures positive monitoring of coal, gas, oil or combination fuel-fired furnaces. Absence or failure of flame is sensed and accurately signaled—or relayed to control auxiliaries—without use of external relays or amplifiers.

Here are other distinctive features that make this new Bailey Flame Detector outstanding:

Wide temperature range . . . is suitable for use in areas with ambient temperatures from −20 to +300° F. Flame sensing element withstands temperatures up to 600° F.

Easy inspection . . . quick disconnect, keyhole mounting simplifies checking of lens condition and detector alignment.

Simple, solid-state circuitry . . . Bailey Flame Detector unit contains only 8 components.

Weatherproof construction . . . design of Bailey unit makes it suitable for outdoor installation.

Why not have your Bailey Engineer give you more information? Call the Bailey district office, or write us.

A147-1

Instruments and controls for power and process

BAILEY METER COMPANY

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In Canada—Bailey Meter Company Limited, Montreal

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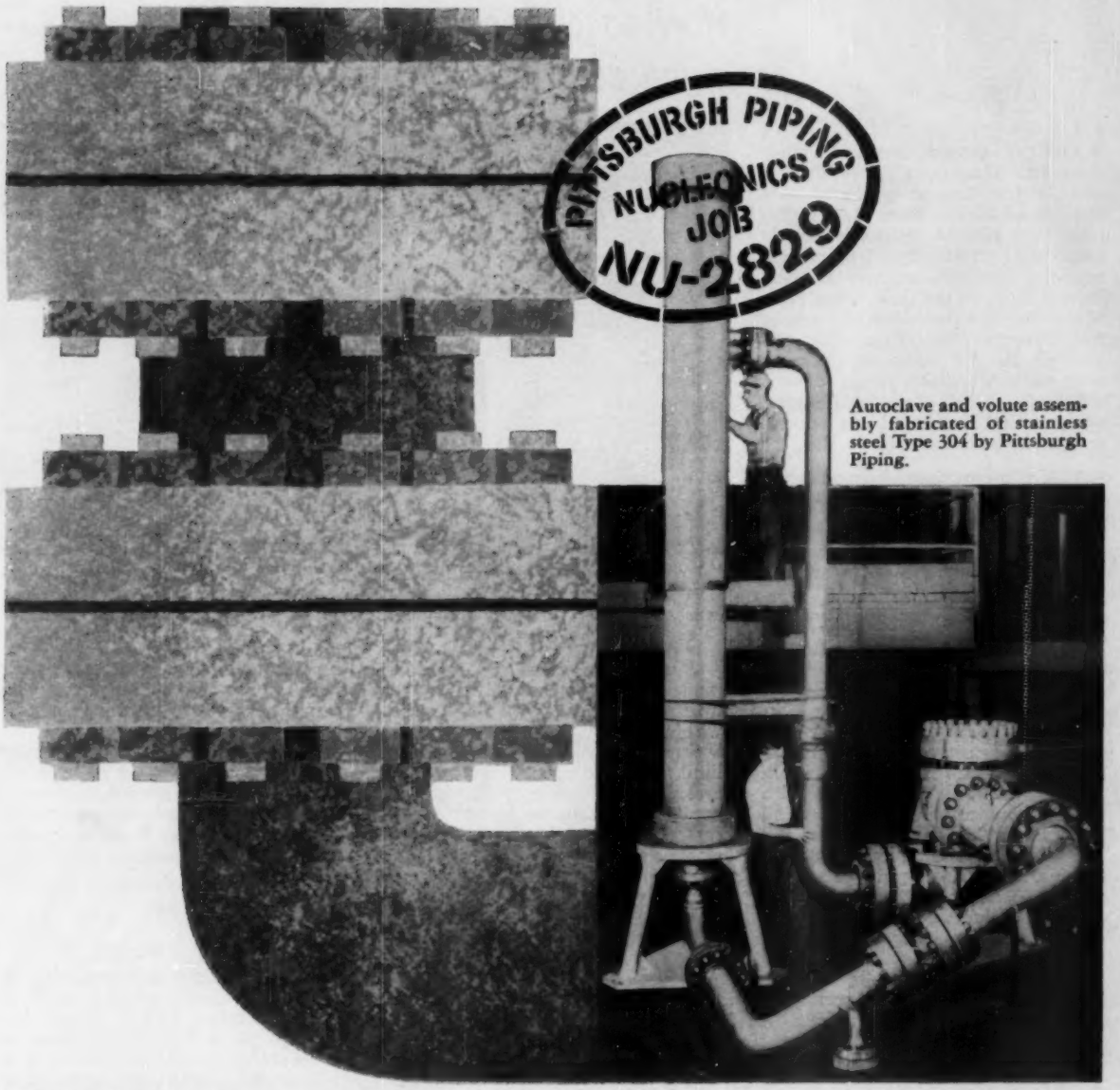

Autoclave and volute assembly fabricated of stainless steel Type 304 by Pittsburgh Piping.

Stainless steel autoclave and volute

shop fabricated by Pittsburgh Piping

At Pittsburgh Piping highly specialized methods, machines, and apparatus have been developed and are employed in fabricating and testing alloy piping and related components of nucleonic installations . . . a natural out-growth of our experience in fabricating high-temperature, high-pressure piping for central stations. We pioneered the application of austenitic steel piping materials for central power stations, and fabricated piping for America's first atomic-powered submarine and central station. The autoclave and volute assembly is typical of our current activities in nucleonics. If your work requires test loops, pressure vessels, high-pressure piping fabrication, or similar components for nucleonic installations — investigate Pittsburgh Piping. Our representative will call at your request, or we will be glad to have you visit our plant.

PIONEER FABRICATOR OF HIGH PRESSURE PIPING FOR NUCLEONICS

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how to choose the right colorimetric analyzer

CRITICAL process decisions must often wait hours upon the result of a trip to the laboratory for a wet analysis. But for those determinations that can be performed colorimetrically, continuous, automatic endpoint analysis can now be performed right on the plant floor. New Milton Roy instruments continuously run through every step of a wet analysis in the parts-per-million—even parts-per-billion range without supervision. And any colorimetric analysis that fits these basic requirements can be automated:

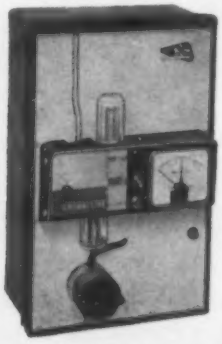
1. No more than four reagents required.
2. All interfering ions can be eliminated.
3. No heating, filtering, extracting, or decanting needed.
4. Clean and clear samples and reagents.

"A completely automatic quantitative analysis lab" describes Quantichem colorimetric analyzers. The unit illustrated above analyzes silica in parts-per-billion concentration, safeguarding boiler and turbine at a major electric generating utility.

When to use the Quantichem® analyzer

Extremely sensitive Quantichem analyzers measure concentrations in parts-per-billion (ppb) ranges with accuracy approaching ± 3% of full scale, and sensitivity of ± 1% of full scale. Typical determinations include soluble silica (0-50 ppb), dissolved oxygen (0-30 ppb), copper, soluble iron, hydrazine, and others requiring up to four chemical reagents.

A dual beam optical system and the use of two sample cells (one as a reference cell) eliminate all possibility of errors in measurement due to physical interference with the light path, different phototube aging characteristics, sample turbidity, sample color, and dirt on cell windows.



All the benefits of single-reagent automatic colorimetric analysis are provided by the simple, compact and inexpensive Chemalyzer analyzer. Recording is optional with this unit.

Unique Minus Delta P® metering pumps, housed in the analyzer, meter up to four reagents with accuracies within ± 0.25%.

Standard designs include a built-in limit alarm and circular or strip chart recorder with single or multiple recorders. As many as eight different samples can be sequenced through a single analyzer, with the analysis of each recorded on an eight-point strip chart recorder. Individually adjustable limit alarms are also available for each of the multiple samples.

Write for Bulletin 1156-1

When to use the Chemalyzer® analyzer

The Chemalyzer unit is designed for simple colorimetric analyses requiring a single reagent, such as water hardness, residual chlorine and phosphates. A simple inexpensive unit, it has no reference cell, and therefore requires samples free of turbidity and discoloration. Though there is no amplification of the measurement signal, concentrations of impurities are detectable to the parts per million range.

One typical application for Chemalyzer instruments is monitoring effluent from zeolite softeners for hardness. At three or six minute intervals (as specified) a fresh sample of effluent is analyzed, and the ppm concentration of hardness is indicated on the face of the instrument. An optional feature is a high limit relay and switch to energize a red light whenever hardness concentration exceeds a pre-set limit. If recording is desired, a potentiometric type recorder with sensitivities of 10-60 mv may be wired quickly to recorder terminals inside the cabinet.

The Chemalyzer is compact, easy to operate, and can be installed in minutes. It operates practically maintenance-free. All parts in contact with reagents are made of suitable corrosion resistant materials.

Write for Bulletin 858-1

®Tradename of Milton Roy Co., Phila., Pa.

How to control with Milton Roy analyzers

The high limit switch available in either instrument can be used to initiate control action directly or through relays. Typical functions include starting or stopping a controlled volume pump and starting an automatic regeneration cycle on a zeolite softener. Through the use of a proportional slidewire in the recorder, the Quantichem analyzer can automatically vary the capacity of a controlled volume pump, to increase or decrease the amount of chemical needed by the process.

Write for complete data. Milton Roy Company, 1300 East Mermaid Lane, Philadelphia 18, Pennsylvania.

milton Roy
CHEMICAL INSTRUMENTATION SYSTEMS

Controlled Volume Pumps • Quantichem Analyzers
Chemical Feed Systems • pH Instruments

For more data circle 503 on Post Card

Engineers' Preview

OF NEWS AND COMING EVENTS IN THE POWER FIELD

MILESTONE in power engineering was reached Sept 30, when the Pennsylvania Electric Co energized its 460-kv transmission line running between Claysburg, Penna., and Saxton, 13 miles away. This is the first 460-kv line to be placed in network operation in the U. S., and it will be given a two-year period of intensive testing. Penelec is one of four domestic operating subsidiaries of The General Public Utilities Corp, which are joined together by a 4269-mile electrical network.

Preliminary operation indicates that pressure as high as 505 kv can be safely carried on the line, which has wires as thick as a man's wrist, held up by porcelain insulators 15 ft long suspended from a variety of wood and steel structures towering to a height of 130 ft. (See NEWS REEL, page 66.)

A 460-kv line, Penelec points out, is capable of carrying 16 times as much electricity as a similar line operating at 115 kv since capacity increases in direct proportion to the square of the voltage. Thus, one EHV line requires less real estate and is cheaper to build than 16 lines operating at 115 kv.

But even with these savings, 460-kv lines would not be feasible unless a concentrated market can be found for large blocks of power and unless this power can be generated in one location at economical rates. GPU's subsidiaries in New Jersey have the customers for the power which its Pennsylvania subsidiaries can generate in the coal fields, such as Penelec's Shawville Station, recently expanded to a capacity of 615,000 kw.

Fourteen companies coöperated with Penelec in this pioneer project. They include: General Electric Co, Ohio Brass Co, Aluminum Company of America, Kaiser Aluminum and Chemical Corp, Pennsylvania Transformer Div of McGraw-Edison Co, I-T-E Circuit Breaker Co, Preformed Line Products Co, Union Metal Manufacturing Co, Rilco Laminated Products, Inc, Hughes Brothers, Inc, Bethlehem Steel Co, and Copperweld Steel Co. Construction was shared by the Sordoni Construction Co and Day & Zimmerman, Inc.

THIS YEAR, rural electrification completed its 25th year as a Federal-stimulated movement. It was on May 11, 1935, that President Roosevelt signed the executive order which created the Rural Electrification Administration. REA has been a lending agency of the Dept of Agriculture since 1939.

Only 10.9 per cent of all farms in the United States had electric service in 1935. REA estimates that of the total farms recorded in the 1954 Census, about 4.6 million, or 97 per cent, were electrified by July 1, 1960. A little more than half of these farms get electricity from REA-financed systems.

REA has made about 93 per cent of its electrification loans to cooperatives organized under state laws by rural people seeking electric service. As of July 1, 1960, REA had approved over $4.1 billion in loans to 1087 borrowers. They included 986 coöperatives, 50 public districts, 27 other public bodies, and 24 electric companies. On July 1, 1960, the borrowers were operating more than 1.4 million miles of line serving nearly 4.8 million consumers in 46 states, the Virgin Islands and Puerto Rico.

ELECTRIC POWER INDUSTRY is increasing its generating capability by 12.6 million kw during 1960 — for a total of 175.9 million kw by the end of the year. So reports the Edison Electric Institute in its 28th semi-annual power survey.

This year's addition to U. S. generating capability accounts for an increase of 7.7 per cent over the capability recorded for December, 1959. With expansion proceeding at the average annual rate of more than 7 per cent, total capability at the end of 1963 is scheduled to reach 211 million kw.

This December's peak load for the total electric utility industry will reach 137 million kw, EEI says, 9.4 per cent over last year's December peak. By 1963 it is expected to reach 169 million.

WASHINGTON Public Power Supply System, in coöperation with more than 55 other utility systems in Oregon, Idaho and Washington, is seeking a license from the Federal Power Commission to build a giant, multi-purpose hydroelectric project on the Middle Snake River between Oregon and Idaho.

Construction of this Nez Perce reservoir area would take an estimated five years. Availability in the late 60's or early 70's of Nez Perce power within 150 miles from the power plant at a delivered price to industrial consumers of 3¼ to 3½ mills is a prospect which is attracting a number of major national electro-process industries. It is said that demand for Nez Perce power by industry could amount to an estimated 750,000 kw.

The Nez Perce pool would be no

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wider than 1000 feet in certain precipitous portions with the canyon walls rising 3500 to 4000 feet above the pool, giving it a rugged, fjord-like quality not to be found elsewhere on the U. S. mainland.

BABCOCK & WILCOX has a contract from the Tokyo Electric Power Co to manufacture what will be the largest steam generating unit built in the United States for export to Japan. It is also said to be the first unit of its design to be purchased by any utility operating abroad.

The boiler is one of B&W's Universal Pressure series. Using the once-through method, the unit is designed to operate below critical pressure at 2500 psi.

When the boiler goes on line in the fall of 1963 at Tokyo Electric's new Goi station, it will produce 2,000,000 pounds of steam per hour at a temperture of 1060 F and a pressure of 2500 psi with reheat to 1055 F.

Operating at full load, the unit will burn 17,000 gallons of oil hourly to provide 265,000 kw of electrical power for the Tokyo Electric system, which now serves a population of over 24 million people living in a 15,000 sq mile area.

STUDY-BY-MAIL safety course for industrial foremen is available from the National Safety Council in Chicago. Based on educator-approved teaching methods as used in the armed forces during World War II, the course saves the cost of pulling men off productive jobs for classroom study, while providing a means of developing supervisory safety skills.

Enrollments for 1961 sessions of the Council's Safety Training Institute are now being accepted. This is a series of one-week courses in accident prevention.

$25,000 AWARD program for progress in arc welded design has been announced by the James F. Lincoln Arc Welding Foundation. Cash awards are being offered for papers describing the welded steel design of either machines or structures. The competition is open to any U. S. resident who has taken part in the design, planning, or production of the design described in his paper.

First award in machines will be $3000; second and third awards will total $1500 each; five fourth-place awards amount to $500 each; ten fifth-place awards are $250 each; while 20 persons will receive sixth-place awards of $100 each.

Complete rules may be obtained from the James F. Lincoln Arc Welding Foundation, P. O. Box 3035, Cleveland 17, Ohio. Competition closes July 17, 1961.

WORTHINGTON CORP has received contracts to supply air conditioning equipment to two of the largest office buildings in the United States. Approximately $1.5 million, the contracts call for furnishing nearly 15,000 tons of air conditioning. The new buildings are the 59-story, 2.4 million sq ft Pan Am Building in New York, and the 44-story Humble Oil and Refining Co Building in Houston.

GROUND has been broken at Parr, S. C., for the Southeast's first atomic power project. This is a 17,000-kw generating station of Carolinas-Virginia Nuclear Power Associates, a utility group made up of Duke Power Co, South Carolina Electric and Gas Co, Carolina Power and Light Co, and Virginia Electric and Power Co.

The plant will be completed in mid-1962. Westinghouse is responsible for development and design of the reactor plant and is furnishing equipment for it. Stone & Webster is architect-engineer for the plant.

The project represents the first time that private companies have invested in a reactor that will use heavy water both as a coolant and moderator.

While heavy water requires processing and is more expensive initially, its use is said to offer the potential of developing large power reactors which need only natural uranium for fuel, thereby reducing the cost of fuel processing.

BONNEVILLE Power Administration and Webb & Knapp, Inc, of New York, have signed a 20-year contract for electric power to supply a new type of steel mill Webb & Knapp plans at Anaconda, Montana. The contract calls for delivery of 120,000 kw of power. Half of the supply will be delivered starting July 1, 1963, and the remainder by November 1, 1963. About 45,000 kw are firm and 75,000 are secondary industrial type. Power revenues are expected to gross about $2,100,000 annually when full requirements are met.

The new mill will have a 350,000 tons annual capacity. It will be the largest steel producing facility in the Northwest, and will use the new Strategic-Udy process to make steel from iron left in discarded copper slag at Anaconda Co's large smelter at Anaconda.

AMERICAN STANDARD Requirements for Varnished Cloth Insulated Cables, C8.13–1960, has been approved as an American Standard by the American Standards Association. The standard was originally developed by the Insulated Power Cable Engineers Association. It applies to all sizes and classes of underground, aerial and indoor power cables — operating at voltages not exceeding 10,000 v for nonshielded multiple conductor cables and 28,000 v for other types and maximum conductor temperatures ranging from 70 to 85 degrees calcius — which are insulated with varnished cloth and used for the transmission and distribution of electrical energy.

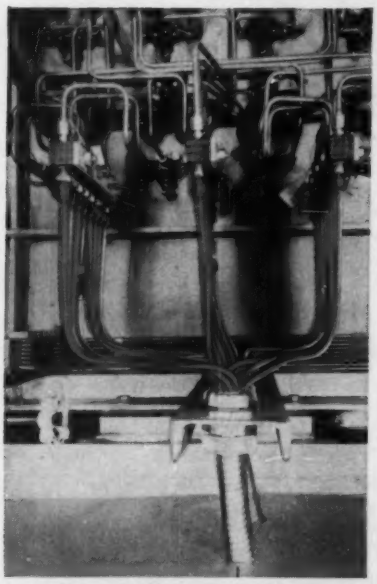
ISA will hold its Winter Instrument-Automation Conference and Exhibit in St. Louis, Jan 17–19, at the Sheraton-Jefferson Hotel.

15th International Heating and Air-Conditioning Exposition is set for Feb 13–16, 1961, at Chicago's International Amphitheatre. Sponsor is the American Society of Heating, Refrigerating & Air-Conditioning Engineers.

Second International Heat Transfer Conference will be held in Boulder, Colorado, late in 1961. Last such conference was held in London in 1951. Conference secretary is Dr. S. P. Kezios, professor of mechanical engineering at Illinois Institute of Technology, who reports that more than 300 manuscripts outlining advances in the field of heat transfer technology have already been submitted for consideration as discussion topics. Chairman for the conference is A. C. Mueller of DuPont.

BAILEY ARMORTUBE is available with *A*, thermoplastic sheath over steel armor; *B*, thermoplastic sheath under steel armor; *C*, thermoplastic sheath over and under steel armor; or *D*, with just steel armor.

For its "Armortube" control system cables, Bailey specifies Anaconda precision copper tube in long coils



A TYPICAL INSTALLATION of Bailey Armortube in a large utility, indicating the large number of separate lines carried by two easily installed cables.

Armortube® flexible, armored, multiple-tube cable made by Bailey Meter Company, Cleveland, Ohio, has saved up to 40% of single-tube installation and maintenance costs in pneumatic, metering and control systems.

Armortube cable is available in lengths up to 1000 feet and in bundles of up to 19 individual ¼" O.D. copper tubes. Steel interlocking armor protects the tubes from mechanical damage and simplifies installation. In addition, various combinations of thermoplastic sheathing are available to provide further protection from moisture and corrosive atmospheres during and after installation.

CLEAN AND DRY. The copper tubes must meet rigid quality specifications, and Bailey has found that Anaconda copper tube consistently meets its requirements. Anaconda takes special care to see that inside surfaces are clean, smooth, and bright—free from dust, dirt, or metal chips which might interfere with the operation of delicate air and hydraulic circuits. Tube ends are sealed to keep out moisture and foreign matter during storage.

FLEXIBLE AND ACCURATE. Anaconda copper tubes are uniformly soft, highly flexible—for easy bending during installation. And they are accurate in size and shape.

LONG LENGTHS. For applications such as instrumentation, Anaconda can produce copper tubing in coils up to 2200 feet for ¼" O.D.—up to 1400 feet for ⅜" O.D.—up to 1000 feet for ½" O.D.

QUALITY TUBE AND CREATIVE TECHNICAL SERVICES. Whatever your requirements for precision copper tubing—instrumentation or capillary tubing, or restrictor tubes—Anaconda specialists can help you find the most economical way to do the job. For such technical assistance, see your Anaconda representative, or write: Anaconda American Brass Company, Waterbury 20, Conn. 6089L

ANACONDA®
INSTRUMENTATION TUBING
Anaconda American Brass Company

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Tracers

COMMENT, OPINION, AND NEWS ABOUT PEOPLE

▶ **Henry Blanchard,** P. E., of the Pennsylvania Public Utility Commission, writes on the subject of page perforation:

> Being a constant reader of POWER ENGINEERING, and one who appreciates the valuable information contained therein, makes me wonder why you have never thought of having the sheets perforated to give the readers an opportunity of filing the information they are most interested in without having to tear the entire publication apart. I am sure many other readers must think the way I do about this.

We've thought of doing this many times. Main reason that holds us back is that POWER ENGINEERING has a 4.5 pass-along readership. That is, about 4.5 persons read most copies of the magazine. If each reader tore out those pages that were of special interest to him, successive readers wouldn't see a complete issue. There are of course ways around this dilemma, such as checking torn-out articles on the contents cover, and indicating who removed them; but it's an awkward situation.

How do some of you other readers feel about this?

▶ **R. C. Alexander,** engineer of steam plants for the Los Angeles Dept of Water and Power, writes:

> I want to express my appreciation to you and your staff for receiving your magazine each month, and I find it the most informative of all the publications of that type. I particularly like the articles by Mr. Kramer and feel that he is keeping us well informed in the nuclear field.

▶ In reporting the Heat-Power Conference held by the Air Force at Wright-Patterson Air Force Base (September issue, page 71), we stated that **Dr. A. A. Berk** of the Bureau of Mines suggested the use of morpholine and *psychozyline* to control return-line corrosion. As Dr. Berk now corrects the record:

> Now that I have the September issue of POWER ENGINEERING, the puzzling inquiries on "psychozyline" are explained. It is difficult to understand why the reporter did not record cyclohexylamine, as everyone else did, but this must be ascribed to the vagaries of shortland.

Sorry for the confusion.

▶ **E. Robert de Luccia,** vice-president and chief engineer of Pacific Power & Light Co, Portland, and **Joseph K. Dillard,** manager of the electric utility engineering department of Westinghouse, report progress in solving problems in the transmission of electrical energy over distances up to 1000 miles. A two-year study has been going on to find the answers to electrical phenomena problems in circuits exceeding 500 miles in length. The engineers state:

> Voltages up to 690 kv with lines capable of carrying more than 3,000,000 kw of electric power were studied.
>
> Now that it has been determined that such lines can be operated, the utility industry can compare the economics of extra-long-distance transmission with the alternate of transporting fuel to power plants at the load centers of the stations, and has knowledge for determining the best possible sites for the large-capacity generating plants that will be required in the future.

▶ The equipment leasing idea seems to be getting attention in the power industry. Speaking for transportation, **George A. Culp,** vice-president of Service Leasing Corp, says:

> One obvious advantage of leasing is that it frees capital that otherwise would be tied up in trucks or passenger car fleets, and funds so released often can be used to improve a company's profit position. Leasing is an answer to today's profit squeeze.

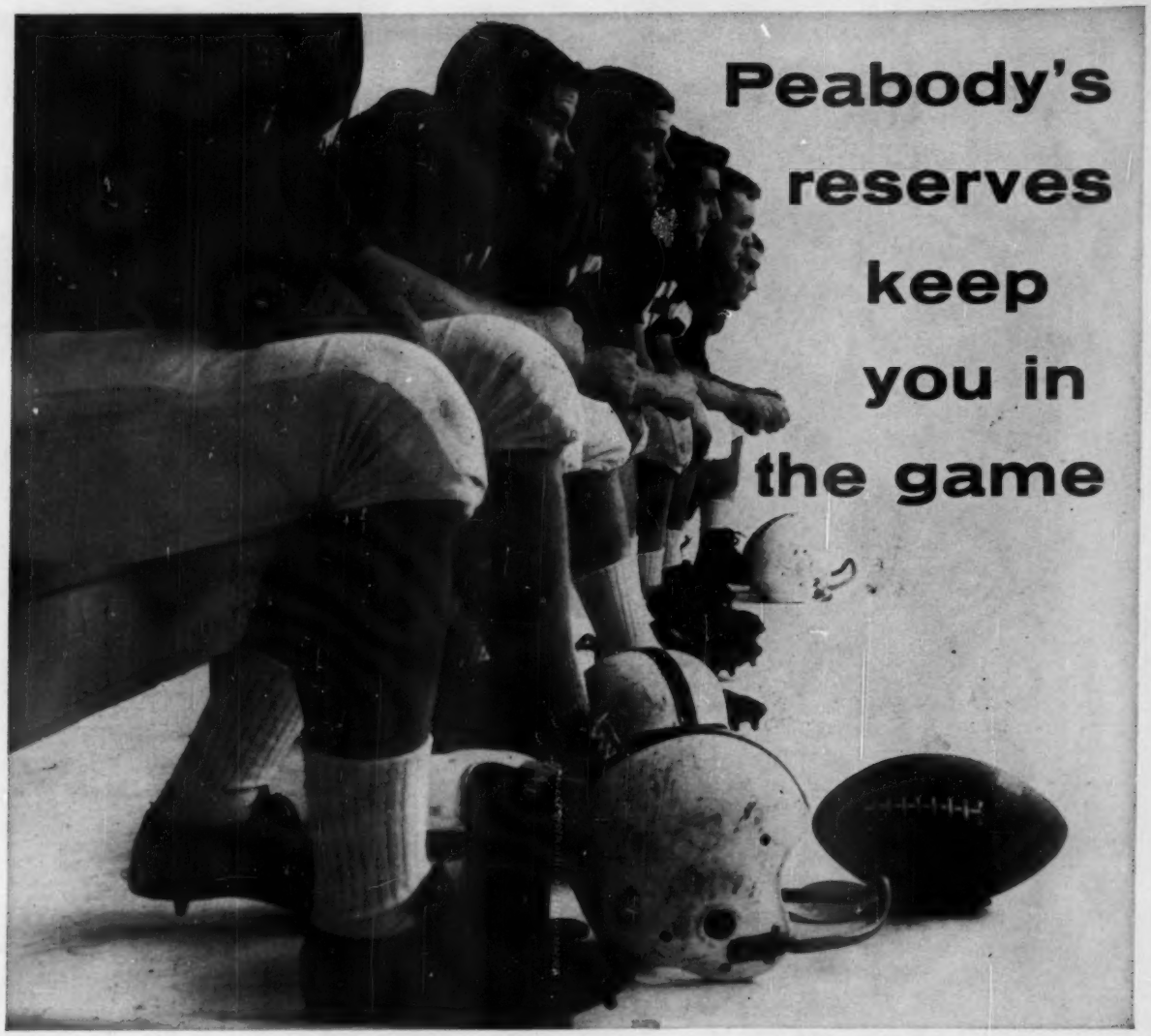
Speaking for package boilers, **Russell E. Emrich,** president of Boiler Engineering and Supply Co, says:

> Boiler users can now lease new boilers. The leasing arrangement makes new boilers available to the user without a capital investment. Working capital is thus conserved for expansion and other purposes. The leasing plan can be used by the lessee for tax advantages. Lease payments are made out of before-tax earnings, not after-tax profits, and are fully tax-deductible as operating expense items. Capitalizing the boiler and depreciating it year by year over its life is not required by the user.
>
> Two types of hedges against inflation are among the benefits of this leasing plan. When equipment is purchased outright and the value of the dollar declines, the increased cost of replacement represents an inflationary loss. In leasing, replacement loss through inflation does not occur. Secondly, lease payments from year to year are made in "cheaper" dollars when inflation continues.
>
> If the lessee wishes to become the eventual owner of the boilers, purchase options can be made at varying levels depending upon the age and type of boilers.

Finally, Westinghouse is offering a new plan that allows modern lighting equipment to be rented for low monthly payments. Leases can include installation costs up to 50 per cent of the selling price of the equipment. They are available for periods of two, three or five years.

▶ **Frederick K. Lindsay,** assistant vice-president of Nalco Chemical Co, has received the 1960 Award of Merit of the Water Conditioning Assn International.

John I. Yellott, whose John Yellott Engineering Associates of Phoenix is well known, announces the establishment of a Solar Energy Laboratory to carry out research, development and testing programs. Address of the new lab is 9051 N. Seventh Ave, Phoenix, Ariz.



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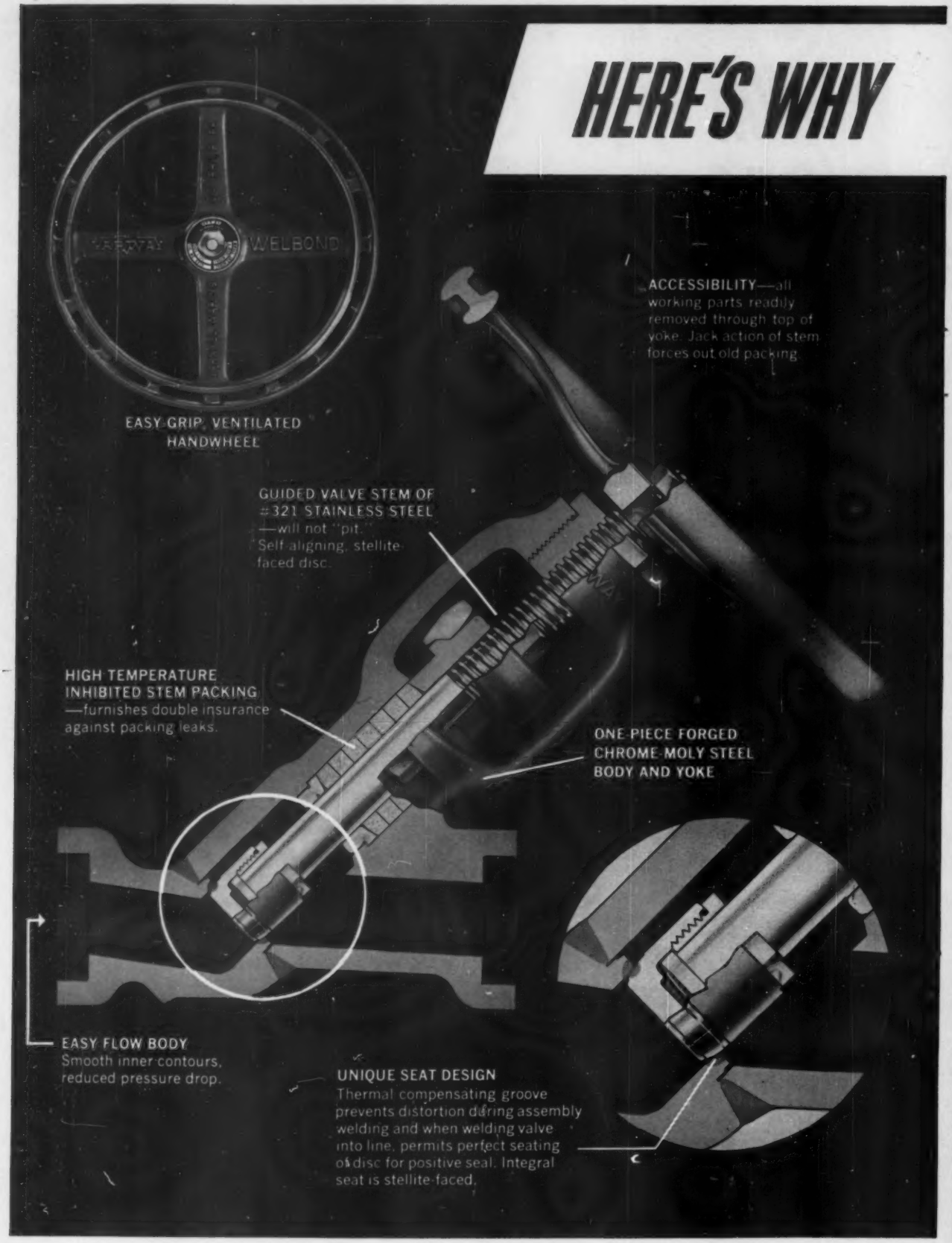
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- ✓ Valve stem of 321 austenitic stainless steel prevents pitting. As an added precaution special inhibited packing gives still greater assurance against stem corrosion.
- ✓ Quick *accessibility* of all working parts through top of yoke.
- ✓ Unique seat design with thermal compensating groove provides non-distorting seat, assuring drop tight shut-off. Reseating tools available for quick "on the job" repairs to valve seat.
- ✓ One-piece forged chrome-moly steel body and yoke.
- ✓ Easy-grip, ventilated handwheel.
- ✓ Smooth inner contours, reduced pressure drop.

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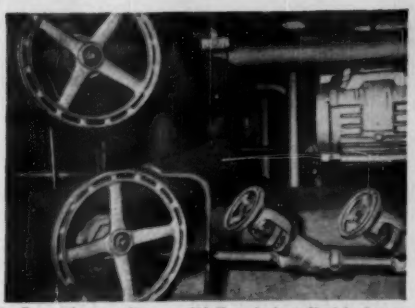
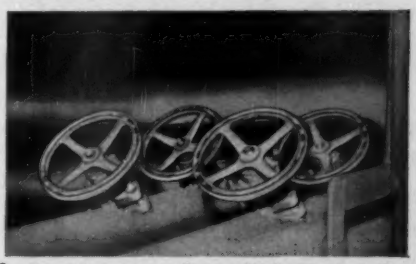
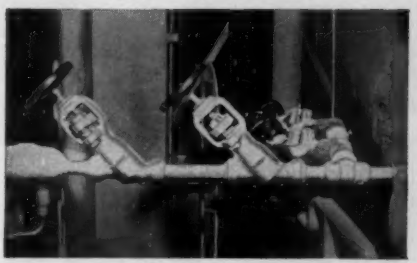
A MARK OF QUALITY IN STEAM ENGINEERING



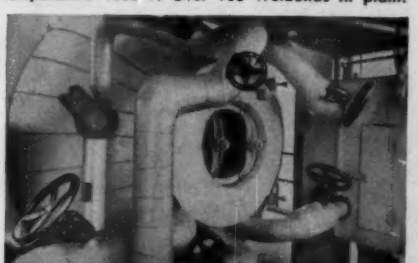
● Four of many Yarway Welbonds installed in large eastern public utility plant. Steam pressure 1850 psi; temperature 1000°F.



● Four of numerous Yarway Welbonds in station of large mid-west utility. These Welbonds installed on header drains.



● Four Yarway Welbonds on main steam line to turbine at southern power plant. Pressure 2310 psi; temperature 1000°F. Over 100 Welbonds in plant.



● Six of more than 900 Yarway Welbonds installed in various power plants of southwest utility. Boiler drum pressure in this plant—2150 psi; superheat temperature 1005°F.

For more data circle 506 on Post Card

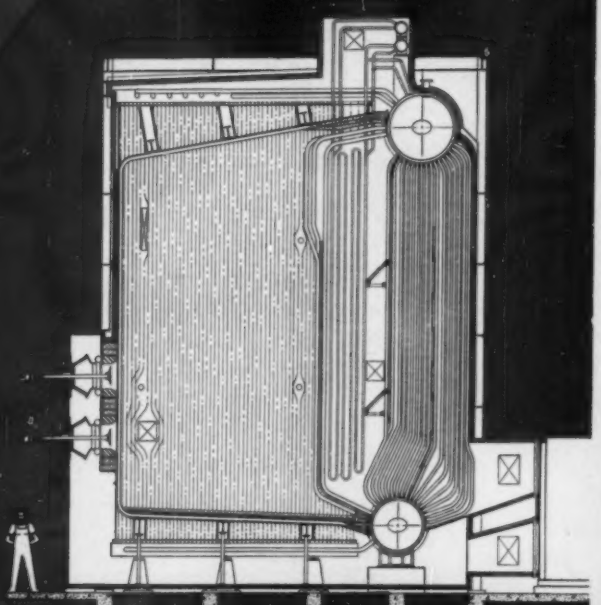
ERIE CITY IRON WORKS

Pressurized

Erie City Multi-pass Pressurized 2-drum Steam Generators are quality designed and quality built for long life and low maintenance. These generators require forced draft only, thereby eliminating the expense and maintenance of the usual additional induced draft equipment . . . also simplifies combustion control systems.

The Erie City Pressurized 2-drum Steam Generator features a welded **inner** seal casing and a welded **outer** casing—**each independent of the other.** The welded inner seal casing is attached to the pressure parts of the unit and expands and contracts as the unit breathes. The outer casing is attached to the structural steel supporting members and remains rigid. The use of properly designed expansion joints allows the pressure vessel and the inner casing to expand and contract in unison with no effect on the outer casing and structural members.

We invite comparison to the Erie City Pressurized 2-drum Steam Generator. Why don't you invite an Erie City Engineer to point out the many advantages of our unique design?



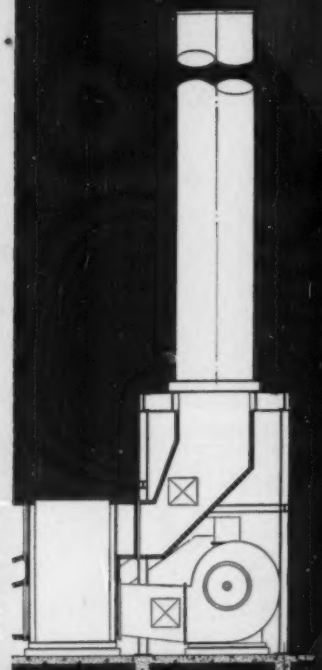
Available for your study of Erie City Steam Generators and Auxiliaries is catalog SB6102-M

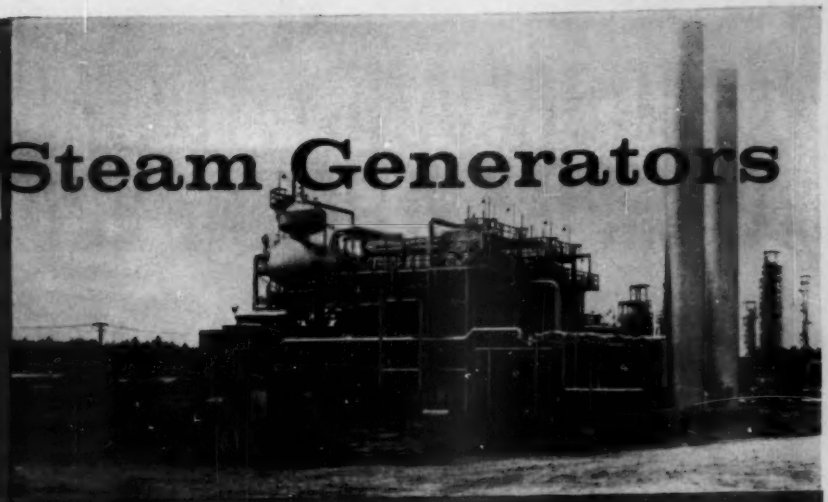
You can depend on ERIE CITY Since 1840 *for steam engineering*

ERIE CITY IRON WORKS · Erie, Pa.

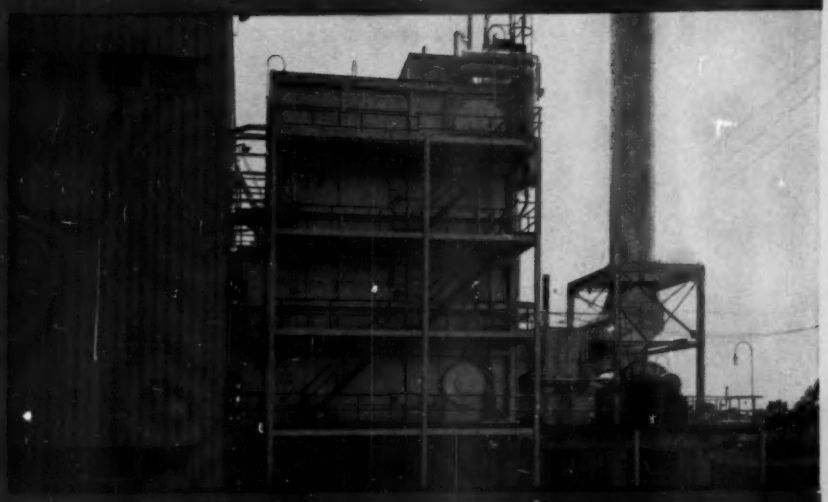
STEAM GENERATORS · SUPERHEATERS · STOKERS · PULVERIZERS
ECONOMIZERS · WASTE HEAT BOILERS · OIL and GAS BURNERS
AIR PREHEATERS · FIRE and WATER TUBE PACKAGE BOILERS

—2-drum Steam Generators

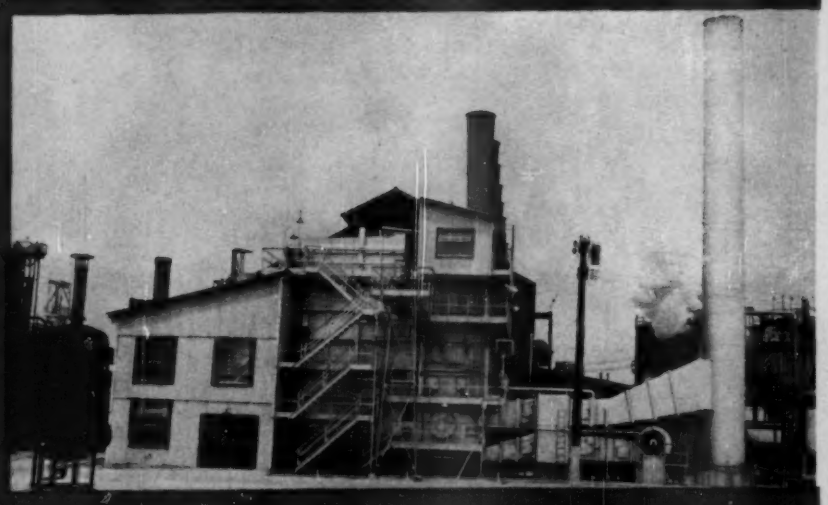




West Coast Oil Refinery with one 450,000 lbs. hr. [illegible] 700 psi, 700° F. steam temperature — one unit of [illegible]



An Ontario Municipality has this 130,000 lbs. hr. pressurized unit designed for 725 psi [illegible]

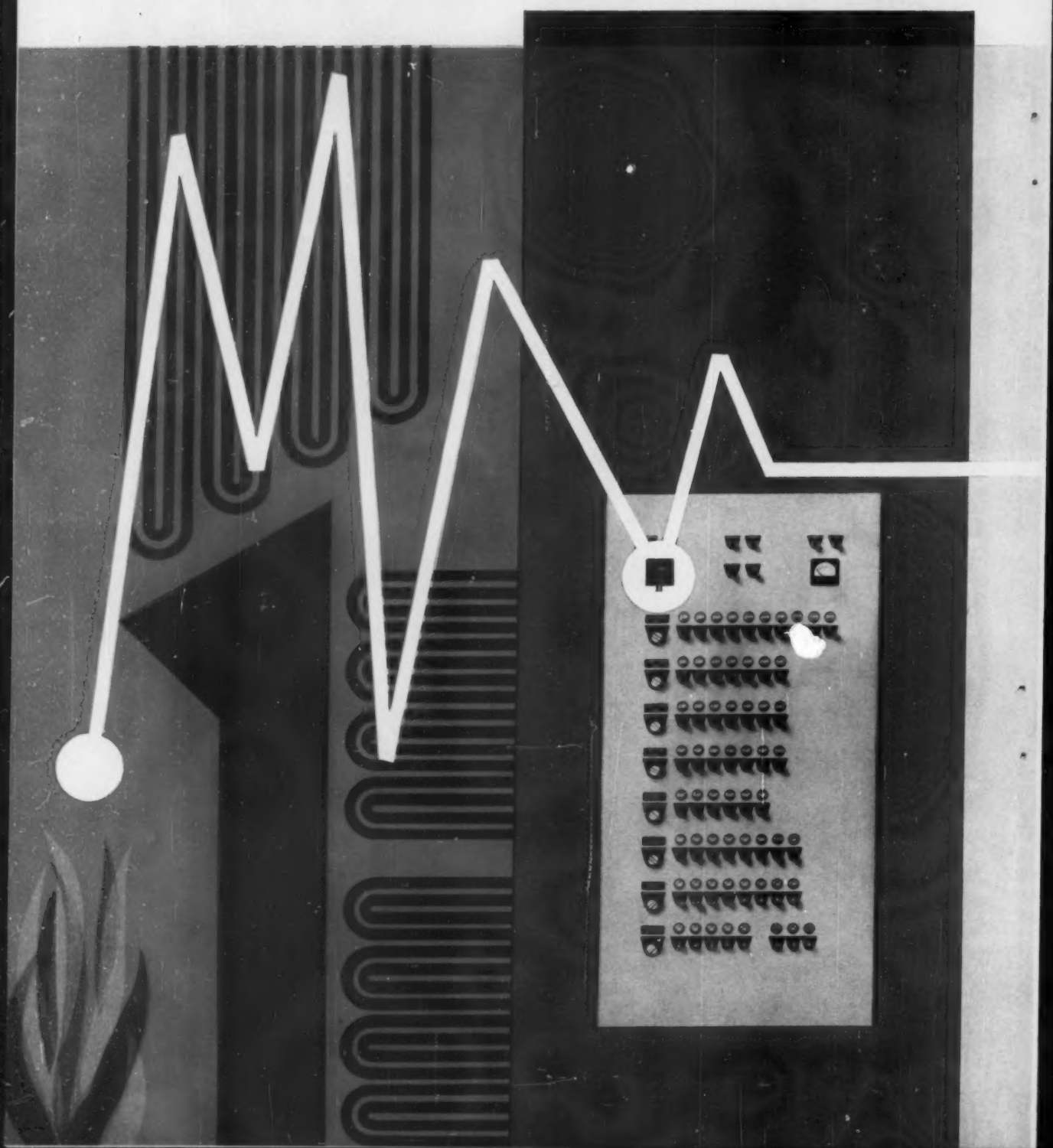


[illegible] petroleum refinery uses this 130,000 lbs. hr. [illegible] generator — 600 psi, [illegible]

For more data circle 507 on Post Card

Diamond developed for more economical power

MONITORMATIC...NEW SELF-CONTROL FOR MORE EFFICIENT BOILER CLEANING



Optimum frequency of blower cycling is assured with Monitormatic . . . Diamond's completely automatic boiler cleaning system.

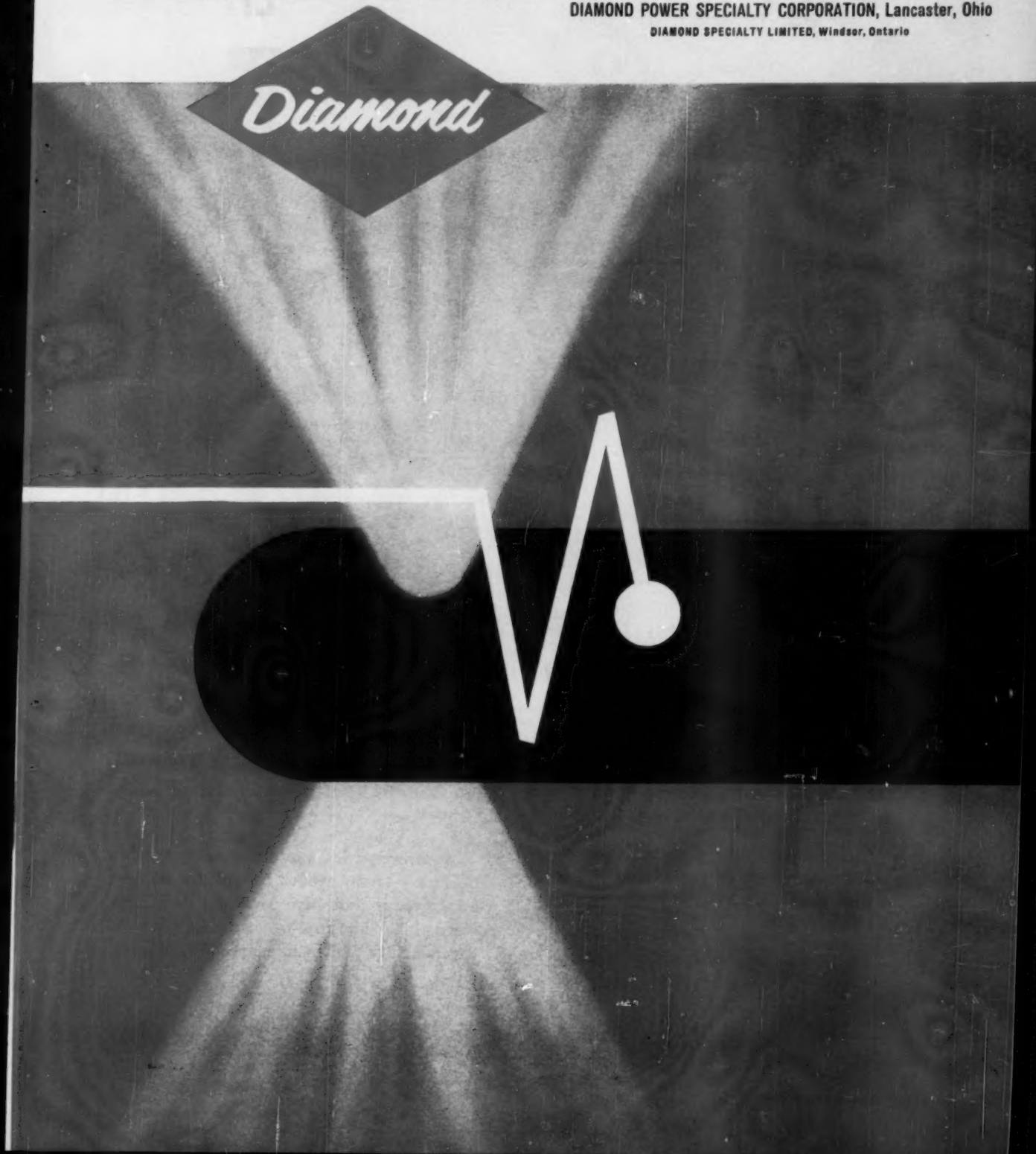
Monitormatic is an automatic method of maintaining constant furnace cleanliness and heat absorption. It responds automatically to changing boiler conditions and eliminates indiscriminate, unnecessary or insufficient blowing. Savings are realized through optimum use of blowing medium, minimized soot blower maintenance, less compressor maintenance if air is used as blowing medium, and reduced operator time. It also automatically adjusts the cleaning system to fuel changes.

Monitormatic is readily and economically applicable to new or many existing Diamond Selectromatic Systems; is another example of why "Diamond Developed" means more economical power generation.

At your request, our Engineers will be pleased to evaluate the application of Monitormatic to your specific system. Call, write or wire for complete information.

DIAMOND POWER SPECIALTY CORPORATION, Lancaster, Ohio

DIAMOND SPECIALTY LIMITED, Windsor, Ontario



OWNER: *Public Service Company of Colorado*
ARCHITECTS: *G. Meredith Musick & Clayton C. Musick*
ELECTRICAL CONSULTANTS: *Swanson — Rink & Associates*
ELECTRICAL CONTRACTOR: *Howard Electric Co.*
TOTAL FLOOR AREA: *77,400 square feet.*

Electrical Protection goes MODERN *with* BUSS Fuses . . .

in the New Service Center of the Public Service Co., of Colorado

This recently completed service center, — located at 2701 West 7th Ave., in Denver, Colorado — has fuses installed throughout the entire electrical system.

The primary voltage at the underground transformer vault is 13,800 volts, 3 phase, 4 wire. Secondary voltage is 120 and 208 — 3 phase, 4 wire.

Installed in the main service entrance are BUSS Hi-Cap fuses; the sub-feeders are equipped with FUSETRON dual-element fuses and the lighting panels are protected by BUSS Fustat fuses.

Modern electrical protection calls for fuses because — fuses cannot be equalled by any other type of protective device for their combined high interrupting capacity, lifetime dependability and maintenance-free features.

1160

THERE'S A BUSS OR FUSETRON FUSE FOR EVERY ELECTRICAL NEED . . .

ALL LIGHTING DISTRIBUTION PANELS AND HEATING PANELS PROTECTED BY BUSS FUSTAT FUSES.

MAIN POWER PANELS PROTECTED BY 2,500 AMPERE BUSS HI-CAP FUSES
MAIN LIGHTING PANEL PROTECTED by 1,500 AMPERE BUSS HI-CAP FUSES.

ALL POWER DISTRIBUTION PANELS PROTECTED BY FUSETRON DUAL-ELEMENT FUSES.

TODAY'S INCREASED POWER REQUIREMENTS EMPHASIZE THE ADVANTAGES OF FUSES

Buss LOW-PEAK fuses;
The revolutionary new protective device

If your installation requires unusually high interrupting capacity and great current limitation plus long time-lag to prevent needless shutdowns, check into Buss LOW-PEAK fuses. Made in N.E.C. sizes from 15 to 600 amperes

Ask for BUSS bulletin LPCS.

With available fault currents reaching 75,000 to 100,000 amps. or more — *safe interruption* of fault currents is essential to guard against ruined equipment, fire hazard and personal injury.

Fusetron dual-element fuses meet todays' demand for safety. They have an interrupting rating of 100,000 ampere rms symmetrical — and for protection of mains or circuits above 600 amperes, BUSS Hi-Cap fuses are designed to safely interrupt 200,000 ampere rms symmetrical.

And fuses remain safe and accurate through the years. They require no expensive maintenance or recalibration — they are always ready to function the instant trouble occurs.

For more information on:

Buss FUSTAT fuses . . . . . write for bulletin SCPS
Fusetron dual-element fuses . . . write for bulletin FIS
BUSS Hi-Cap fuses . . . . . write for bulletin HCS

Bussmann Mfg. Division, McGraw-Edison Co. University at Jefferson, St. Louis 7, Mo.

For more data circle 509 on Post Card

shop-assembled to 120,000 lb/hr capacity

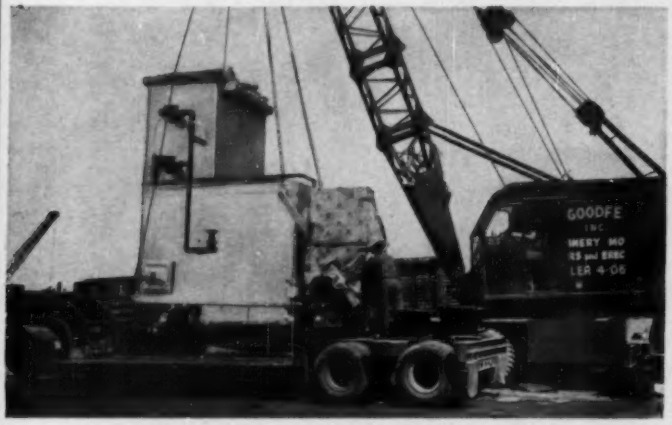
Designed for Industry by

C-E shop-assembled boilers are available for a wide range of industrial, commercial and institutional applications. They are produced by the same C-E engineers who design the world's biggest and most efficient utility boilers—with capacities to 4,000,000 lb/hr and pressures to 5,000 psi. For the most economical solution to *your* steam or high-temperature water problems, write to C-E, outlining your requirements.

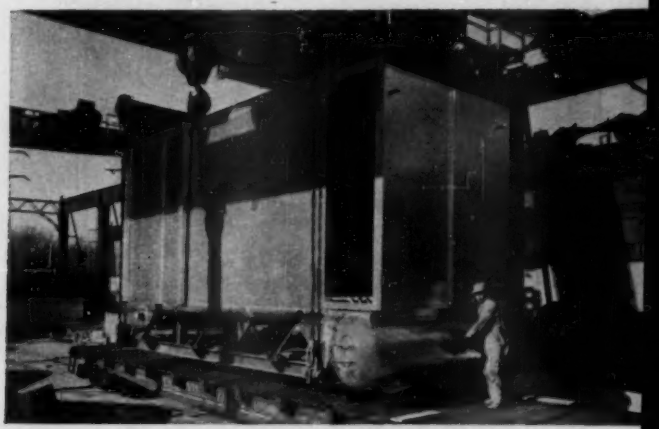
ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS;

To 90,000 lb/hr . . . Type VP — A compact, economical, natural circulation, *package* boiler for the majority of industrial requirements. Steam capacities from 4,000 to 90,000 lb/hr; pressures to 700 psi; temperatures to 750 F. Most sizes shipped complete with firing equipment for oil or gas, setting and forced draft fan arrangement.

To 120,000 lb/hr . . . Type PCC — *For Special Applications* — Shop-assembled, controlled circulation boiler providing high output and high temperatures in a compact unit. Capacities – 80,000 to 120,000 lb/hr; pressures to 1,000 psi; temperatures to 900 F. Designed for minimum installation, operation and maintenance costs.



To 50,000,000 Btu/hr . . . Type HCC — High-temperature water boiler, shop-assembled, widely used for large-scale, economical heating of commercial and industrial installations — including many military air bases. Controlled circulation, pressurized oil or gas-fired from 10 to 50 million Btu; coal-fired to 40 million Btu. Field-assembled units to 300 million Btu.



To 50,000 lb/hr . . . Type WCC — Shop-assembled. Utilizes waste heat from open hearths or chemical processes. C-E controlled circulation design obtains big boiler performance from space-saving units. Capacities to 50,000 lb/hr — and up, depending on waste heat conditions — with pressures to 450 psi and temperatures to 750 F. Capacities of field-assembled units are virtually unlimited.

UTILITY-BOILER ENGINEERS

Write for catalogs —

C-E PACKAGE BOILER, TYPE VP

C-E CONTROLLED CIRCULATION PACKAGE BOILER, TYPE PCC

C-E CONTROLLED CIRCULATION HOT WATER BOILER, TYPE HCC

COMBUSTION ENGINEERING

General Offices: Windsor, Conn. • New York Offices: 200 Madison Avenue, New York 16, N. Y.

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C-2778

PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE

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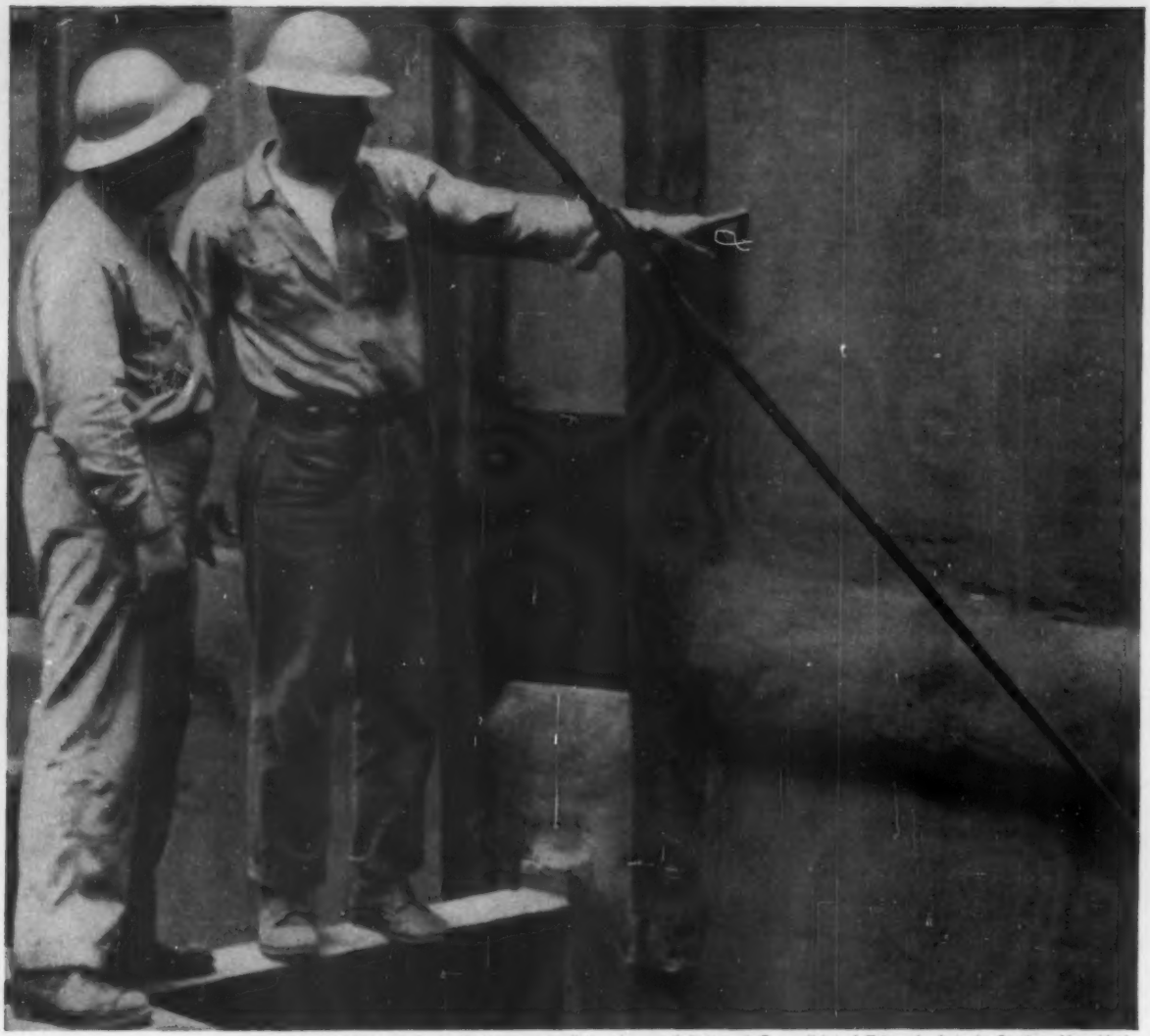

Inspecting newly gunited concrete lining in precipitator at Consolidated Edison's Astoria Station, New York. **Contractor:** Research-Cottrell, Inc., Bound Brook, N. J. **Gunite Contractor:** J. A. McCollum, Inc., Marlton, N. J

Industrial concrete lining resists precipitator corrosion

Concrete linings of LUMNITE calcium-aluminate cement and aggregate are specified for power plant precipitators to protect against the corrosive effects of acid condensate and the abrasion of fly ash. Placement is fast, easy, economical — by guniting, pouring or plastering. Since the concrete reaches service strength within 24 hours, downtime is reduced. For greater convenience there are castables made with LUMNITE cement. These packaged mixtures, available from leading manufacturers of refractories, are ready to place when mixed with water. For more information, write Universal Atlas Cement, 100 Park Avenue, New York 17, N. Y.

"USS," "Atlas" and "Lumnite" are registered trademarks L-207

Universal Atlas Cement
Division of
United States Steel

Offices: Albany · Birmingham · Boston · Chicago · Dayton · Kansas City · Milwaukee · Minneapolis · New York · Philadelphia · Pittsburgh · St. Louis · Waco

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GENERAL GP PURPOSE

FORGED STEEL *INTEGRAL SEAT* METER AND GAUGE LINE VALVES

Union Bonnet, Screw Bonnet and No Bonnet Types

Service proved Vogt GP Forged steel valves are the choice of leading meter and gauge Manufacturers for top performance and unfailing reliability.

They are available in sizes from ¼" to 2" of carbon steel for general purpose duty and of all-stainless where highly corrosive liquids are involved. All stems are one-piece 13% Chrome Stainless Steel with fine pitch threads for accurate regulation of flow. Special packing is furnished when specified.

Catalog F-10 contains the complete Vogt line of valves, fittings, flanges and unions. Available upon request on your letterhead. Address Dept. 24A-FPE

HENRY VOGT MACHINE CO., P. O. Box 1918, Louisville 1, Ky.

SALES OFFICES: New York, Chicago, Cleveland, Dallas, Camden, N. J., St. Louis, Charleston, W. Va., Los Angeles.

Vogt FORGED STEEL VALVES, FITTINGS, FLANGES and UNIONS

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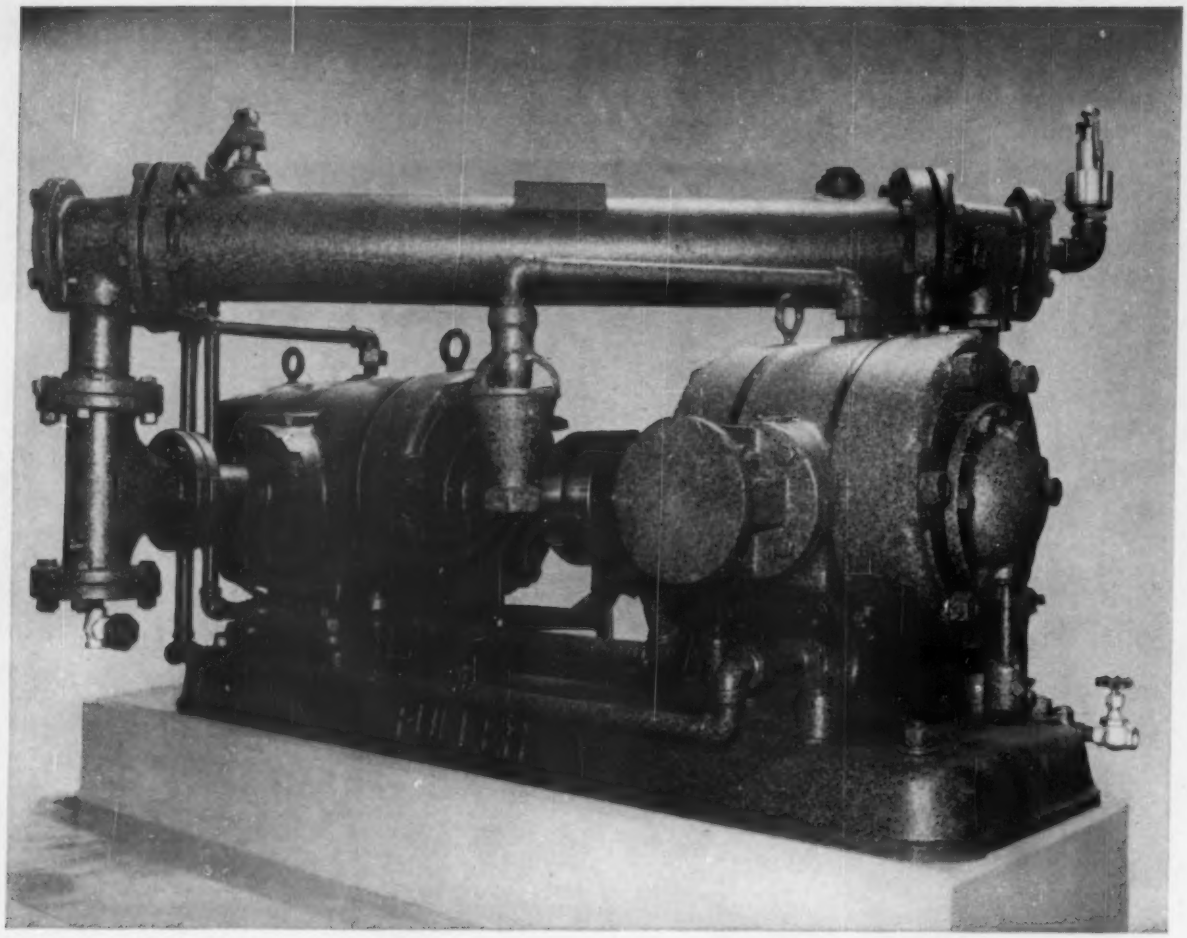

Fuller Compressors With Overhead Intercoolers Offer A New Dimension In Compactness

Fuller Rotary Two-Stage Compressors equipped with Overhead Intercoolers fill the bill where space may be a problem. These compressors produce from 30 to 3300 cfm, pressures to 125 lb. gage and can be readily installed.

These compact Rotary Compressors are vibration-free, thereby eliminating the need for involved and expensive foundations or structural modifications.

The Fuller rotary principle permits complete freedom of reciprocating parts—valves, crankshafts, pistons—cutting the need for frequent servicing and parts replacement. Minor maintenance is all the care indicated for years of serviceability.

For full details on the maintenance-free economy and high performance of Fuller rotaries, write today for comprehensive, illustrated Bulletin C-5A. 2626 C359

FULLER COMPANY
GENERAL AMERICAN

FULLER COMPANY
150 Bridge St., Catasauqua, Pa.
Subsidiary of General American Transportation Corporation
Offices in Principal Cities Throughout the World

Fuller
....pioneers in harnessing AIR

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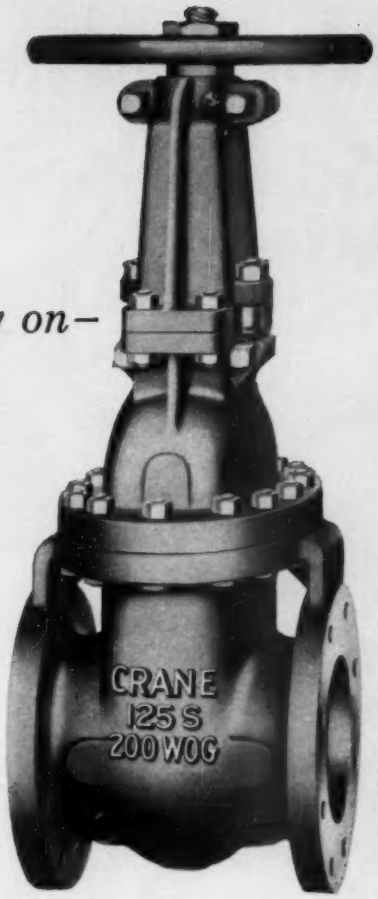
The valves most plants rely on–



No. 465½,
125-pound iron body
gate, bronze trimmed.
Sizes 2" to 48".

CRANE 125-POUND IRON BODY GATES

On general utility services . . . water mains and distribution lines . . . low-pressure steam and hot water . . . air and gas . . . more plants rely on Crane No. 465½ iron body bronze trimmed gates than on any other valve in this class.

Crane iron gates are an up-to-date design with service-proved features. A two-piece, ball-type packing gland for bind-proof packing adjustment . . . shoulder-type seat rings that won't loosen . . . extra-long disc guides to minimize drag on seating faces. All features are carefully planned to yield long, dependable operating life.

To enable you to standardize on these economical, efficient valves, Crane builds them in a full range of sizes. Popular sizes are available from local stocks of your Crane Distributor.

CRANE®

Crane Co., Industrial Products Group, 4100 S. Kedzie Ave., Chicago 32, Illinois

VALVES • ELECTRONIC CONTROLS • PIPING • PLUMBING • HEATING • AIR CONDITIONING

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THE WESTERN PRECIPITATION

"Transistomatic" CONTROL

BY FAR, the Industry's Most Advanced Precipitator Control...

NO TUBES! NO RELAYS! NO COUNTERS!

and carries a Lifetime Guarantee!

In the electrostatic precipitation of dust, fume and fly ash, no installation is completely modern without *automatic* control to maintain optimum Precipitator efficiency as the characteristics of the gas stream fluctuate. Compared with manual control, automatic control is not only more sensitive and more efficient, but actually costs less because of the vital savings it makes in labor and operating costs . . . *savings so important that no profit-minded operator will want to be without them.*

But the important point to remember is this—

Although many manufacturers of precipitation equipment offer units for precipitator automation, no other unit is equal to the "Transistomatic" Control for foolproof simplicity, rugged dependability or control accuracy!

These are not idle claims. They can be easily verified by making your own comparison . . .

Compare ACCURACY! The "Transistomatic" does not base its "sensing" action on spark *frequency* alone—or spark *intensity* alone. Instead, it continuously integrates BOTH frequency and intensity to establish an overall "power value" that provides a new standard of control accuracy!

Compare DEPENDABILITY! The "Transistomatic" unit contains no parts of any kind requiring regular replacement. Moreover, the entire unit is completely sealed—moisture-proof and watertight.

Compare GUARANTEES! The "Transistomatic" is so foolproof and trouble-free it carries *a lifetime guarantee!*

BEFORE YOU BUY ANY automatic precipitation control, be sure to get the complete "Transistomatic" story. See your nearest Western Precipitation representative for full details... or write, wire or phone for this "Transistomatic" booklet!

WESTERN PRECIPITATION
DIVISION OF JOY MANUFACTURING COMPANY

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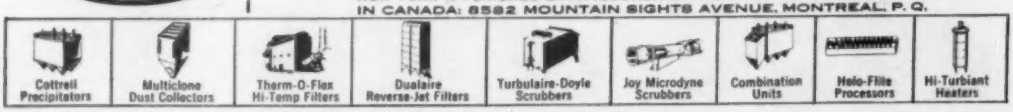
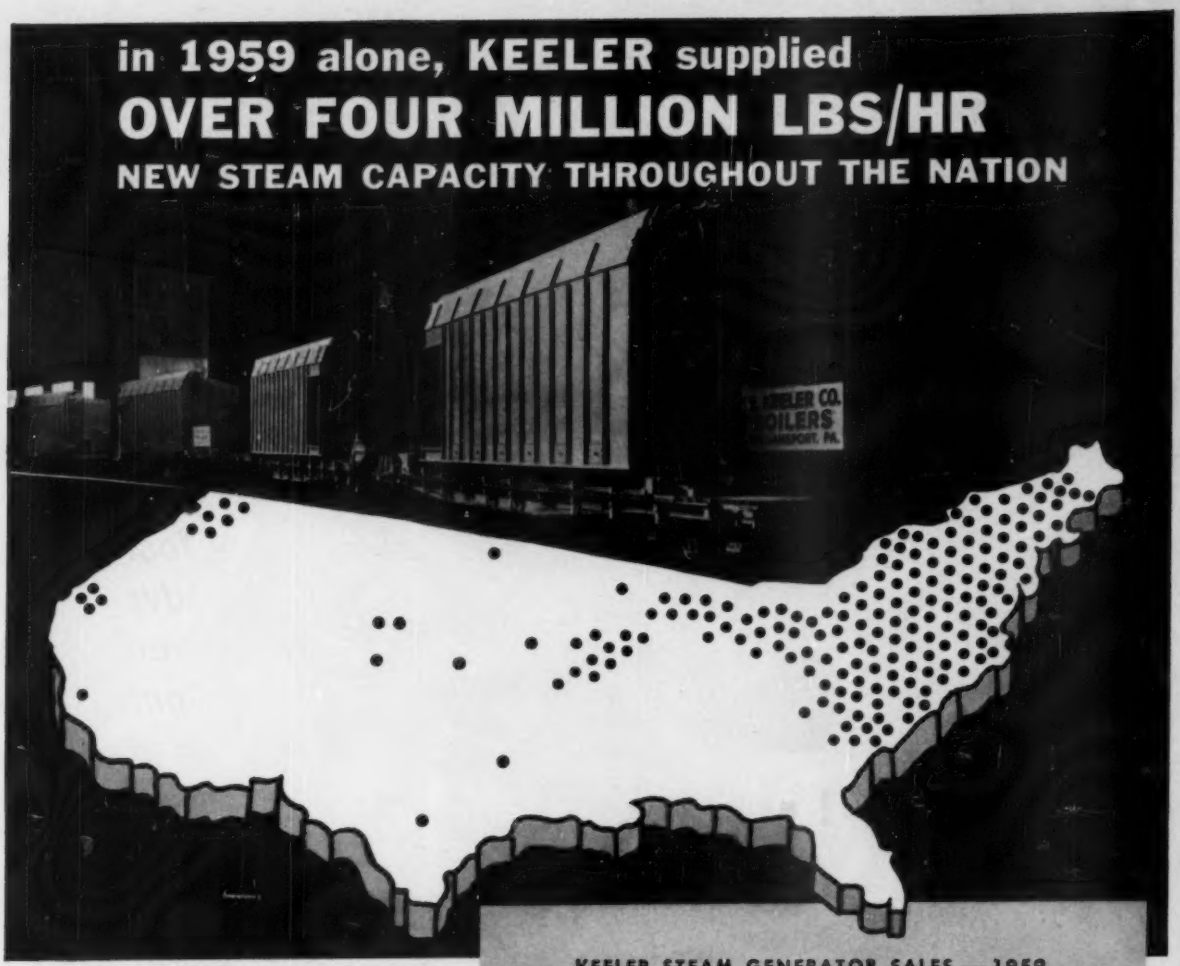
IN CANADA: 8582 MOUNTAIN SIGHTS AVENUE, MONTREAL, P. Q.



For more data circle 515 on Post Card

in 1959 alone, KEELER supplied
OVER FOUR MILLION LBS/HR
NEW STEAM CAPACITY THROUGHOUT THE NATION



A MILLION POUNDS/HOUR MORE STEAM CAPACITY THAN THE YEAR BEFORE

Each dot on the map represents a new Keeler Steam Generator sold during 1959. The group included units for all fuels, all types of firing—for power, process, heat and special steam needs. Total capacity was over 4 million lb/hr—a 1 million lb/hr increase over the previous year.

Yes, Keeler is one of the nation's leading manufacturers of steam generators — from low cost package units up to 100,000 lb/hr and field erected units up to 200,000 lb/hr. *Write for full data . . .* nearly a century of versatility, economy, dependability and experience are yours when you specify and insist upon Keeler quality for your steam requirements.

E. KEELER COMPANY
100-200 West St. • Williamsport, Penna.

—OFFICES IN PRINCIPAL CITIES —
In Canada: Canadian Vickers, Ltd., Montreal, P. Q.

ESTABLISHED 1864

The Seal of Quality in Water Tube Steam Generators

KEELER WATER TUBE *Boilers*

KEELER STEAM GENERATOR SALES — 1959
*Indicates more than one unit

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AMITY DYEING & FIN. CO.
ANDERSON MEM. HOSPITAL*
ANDREWS AIR FORCE BASE, John H. Towers Field*
ATLAS WAREHOUSE & COLD STORAGE COMPANY

BETHLEHEM STEEL CO.*
BOYS INDUSTRIAL SCHOOL
BRAMBLE CANNING CO.*
BUNKER HILL A.F. BASE
BZURA, INC.*

CARSON PECK MEM. HOSP.*
CENTRAL INTEL. AGCY.*
CHARLESTON GENL. HOSP.*
CHARLOTTE MEM. HOSP.*
CHRISTIAN COLLEGE*
CIRCLE WIRE & CABLE CO.
CONTINENTAL CAN CO.*
CORLIN PROCESSING CO.
CORNELL DUBILIER ELEC.
COTTAGE HOSPITAL
CRUNDEN MARTIN MFG. CO.*
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DARST APARTMENTS
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DRESDEN NUCLEAR POWER STATION*
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FAIRFAX COUNTY HOSPITAL*
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FRANKFORT DEPT. of HEALTH

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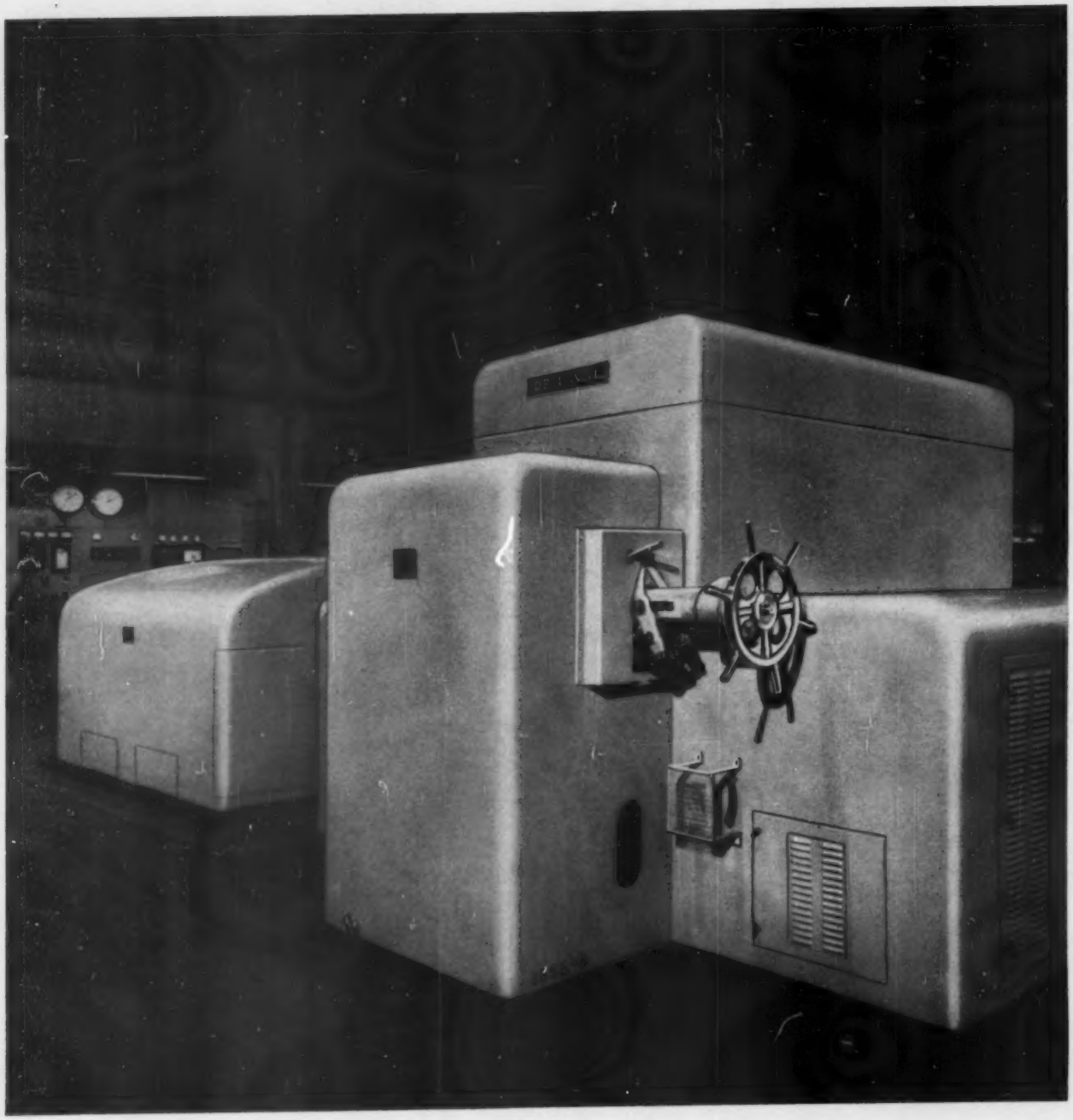
WONDERKNIT CORPORATION

For more data circle 516 on Post Card

DE LAVAL provides power and process steam

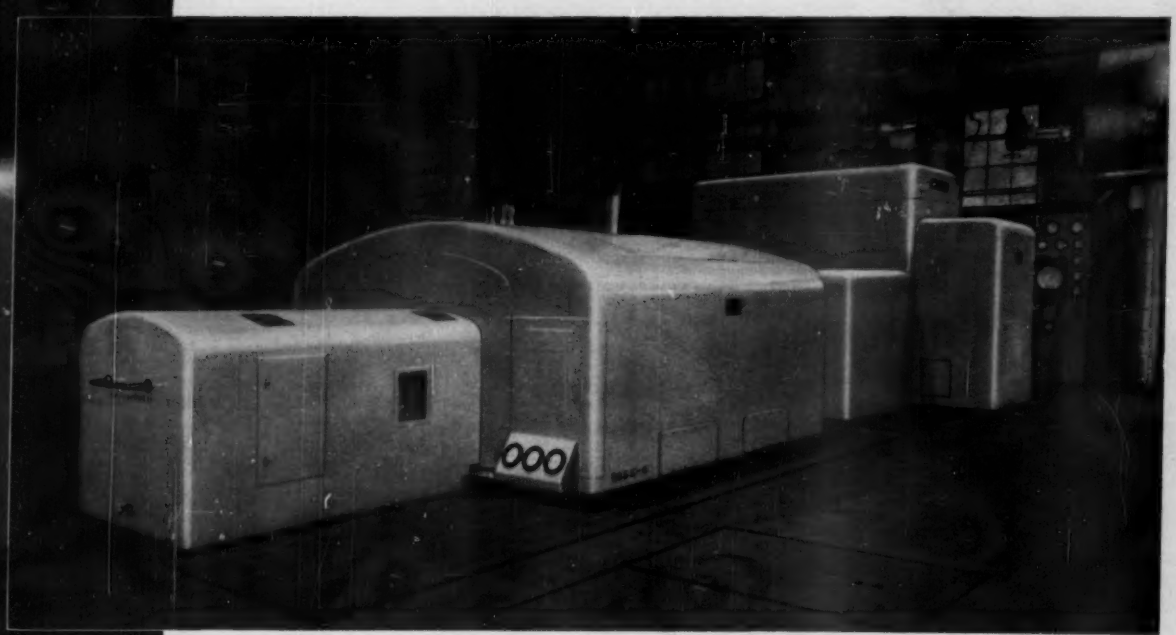


economical
for Corn Products Company

Sargent & Lundy, Consulting Engineers, handle project for new 9375 KW unit.

De Laval design engineers are specialists in meeting unusual requirements. For example, this unit at the Corn Products plant in Pekin, Illinois, is presently operating with 400 psig ISP at 580 F, with 6 stages to develop 5000 KW at a back pressure of 165 psig. Flexible De Laval design will enable this turbine to operate under new steam conditions with 11 stages for which space has been provided in the casing. When operating at its future steam conditions of 850 psig ISP, 700 F, the turbine will develop 9375 KW and will provide 275,000 pounds of steam per hour to the process at a pressure of 165 psig.

De Laval application engineers will gladly give you more information on steam turbines to suit your specific needs.



DE LAVAL STEAM TURBINE COMPANY

816 NOTTINGHAM WAY, TRENTON 2, NEW JERSEY

DL203

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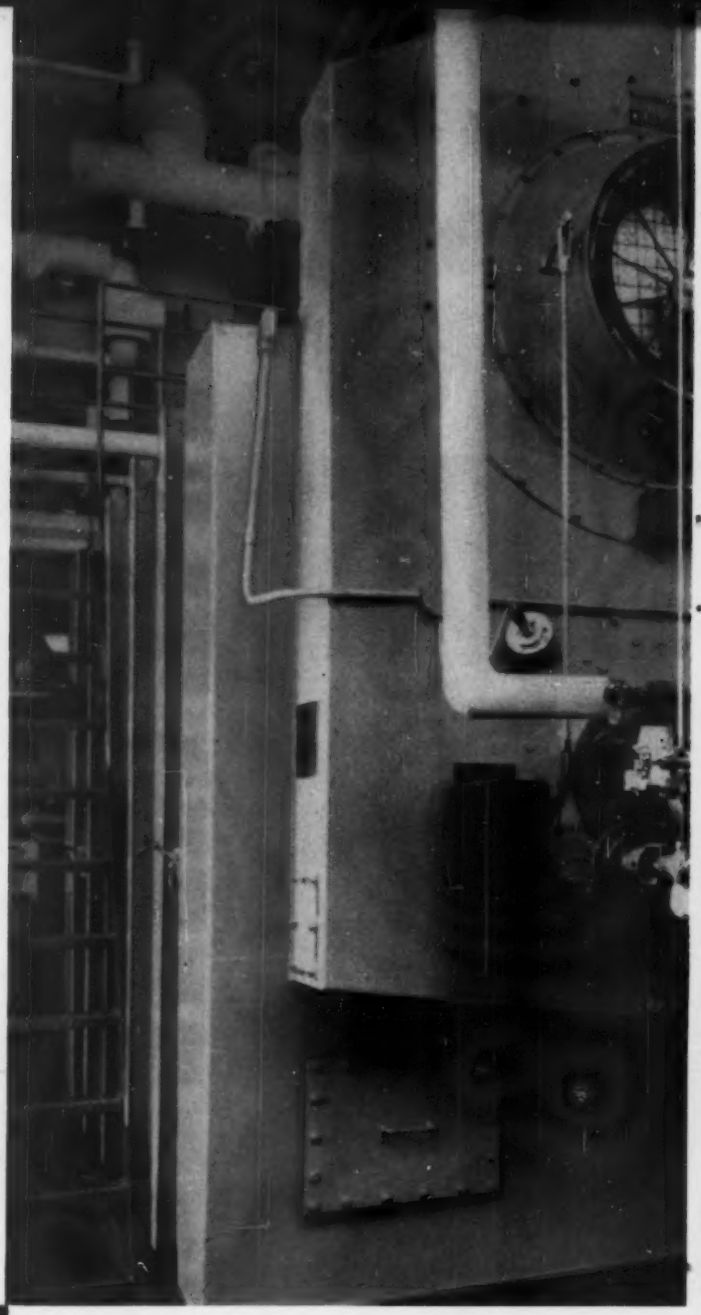
Rx

For Steam at Holy Cross Hospital

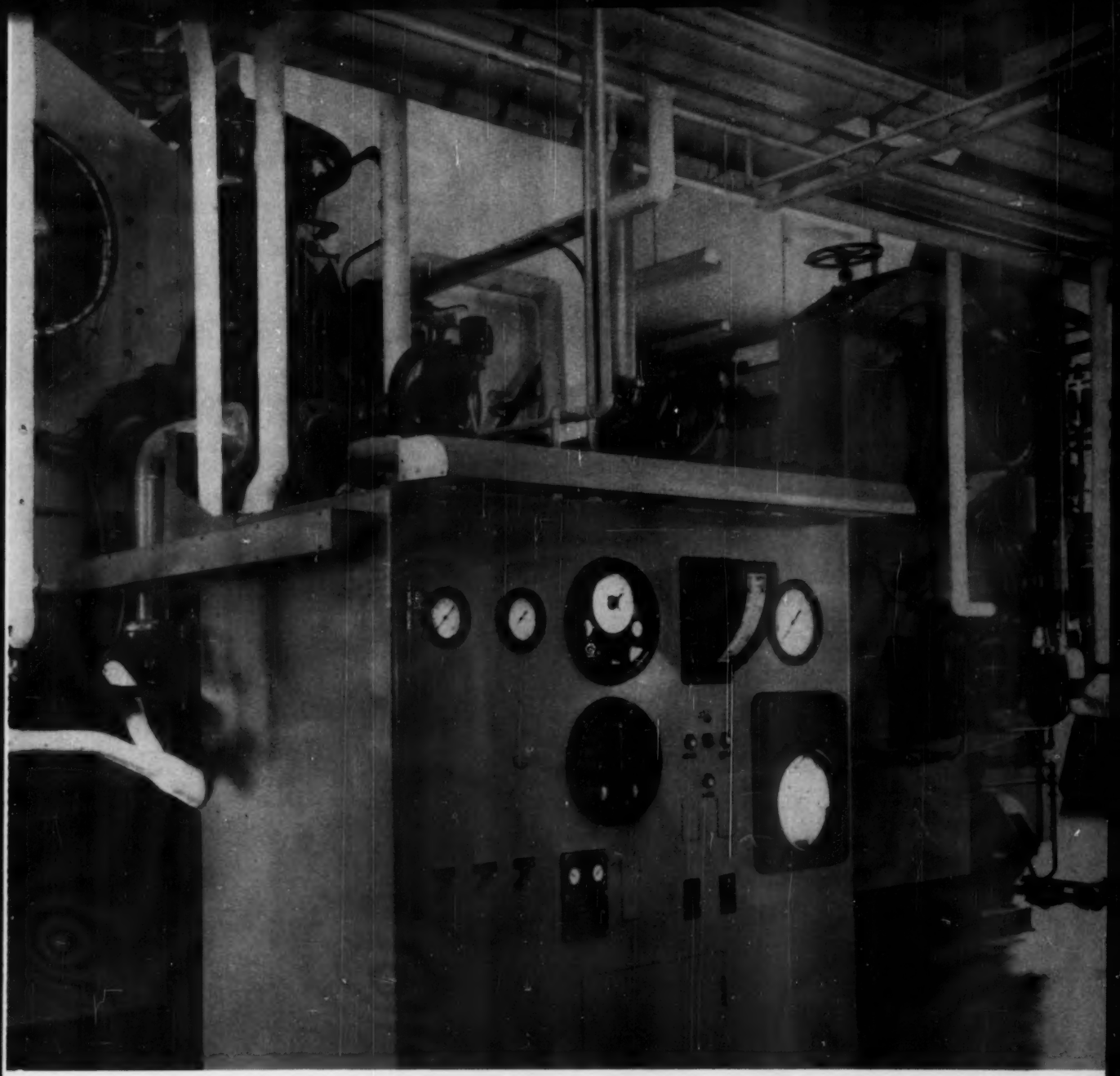


Two new oil and gas-fired B&W Package Units dependably meet crucial 40,000-lb-per-hour steam requirement at well known Chicago hospital

Day after day, year after year, each and every hospital activity is vital. This continuous, reliable hospital service must, of course, be supported by absolute dependability in equipment.

That's why so many institutions such as Chicago's Holy Cross Hospital have selected B&W Package Boilers to meet their steam requirements. Supplying clean, dry steam for critical uses such as heating, laundry, kitchens and sterilizers, B&W Package Boilers have become a standard of dependability in hospitals and other institutions throughout the nation.

Dependability, however, is only part of the story. Budget-



minded hospital management has found the low maintenance, cleanliness of operation, high operating economies, flexibility, rapid response to demand and maximum capacity in minimum space afforded by B&W shop-assembled units equally attractive features. What's more, they appreciate the assurance that at any time during the life of the boiler, even 20 or 30 years hence, B&W's nationwide service organization will be promptly and economically available if needed.

Serving the myriad steam requirements of a vital installation like Chicago's Holy Cross Hospital is further evidence in action of dependable steam generation by B&W. Whatever *your* steam requirements . . . whatever your most economical fuel . . . B&W has the boiler best suited to your application. Your local B&W representative has all the facts on your area. Please call him soon. The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

B&W—THE NATION'S LEADING MANUFACTURER OF INDUSTRIAL BOILERS

G-981-1B

B&W

THE BABCOCK & WILCOX COMPANY

BOILER DIVISION

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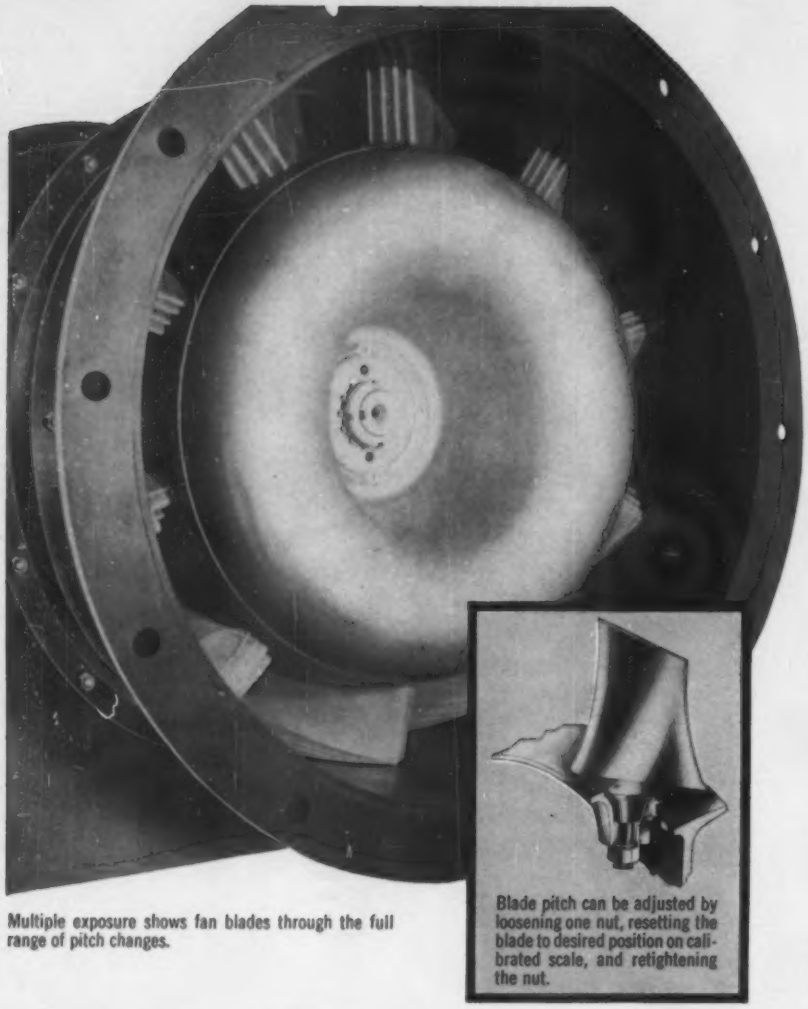

Multiple exposure shows fan blades through the full range of pitch changes.

Blade pitch can be adjusted by loosening one nut, resetting the blade to desired position on calibrated scale, and retightening the nut.

Joy Design Means:

MINIMUM POWER CONSUMPTION WITH VARIABLE FAN OUTPUT

Blade pitch on Joy Axivane® Fans can be adjusted easily. This means that the volumetric output of Joy fans can be varied by as much as ± 20% without any sacrifice of fan efficiency, and therefore with minimum power consumption. And with no efficiency losses such as are encountered with dampers and variable inlet vanes. (Where efficiency losses may be tolerated, the volumetric output may be changed by as much as 400%.)

Even at full load, Joy Axivane Fans are more efficient than propeller, tube-axial and centrifugal fans. The direct drive achieved by mounting the motors inside the fan housings eliminates drive losses, and the vane-axial design gives maximum aerodynamic efficiency. Mounting the motors in the housings also makes the Joy Axivane Fans more compact, and less costly to install.

Fans available range from types which weigh as little as a pound and have a diameter of a few inches, up to some which weigh tons and have diameters up to twelve feet. If you need spot cooling, area ventilation, or any movement of air, Joy can supply the most efficient answer.

For complete information, write for Bulletin 1278-56C.

AIR MOVING EQUIPMENT FOR ALL INDUSTRY

JOY

Joy Manufacturing Company
Oliver Building, Pittsburgh 22, Pa.

In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario

For more data circle 519 on Post Card

Current Catalogs

Fans and Blowers

101 Space Saving Fans — Features and advantages of Westinghouse Electric Corp.'s airfoil centrifugal fan which boasts high efficiency characteristics of a centrifugal fan yet requires less than half the installed space are detailed in 14-pp Catalog 1125. Illustrated with photos, construction and installation diagrams, it contains performance curves and detailed selection tables.

102 Draft Fans — Information on Chicago Blower Corp.'s high volume radial tip mechanical draft fans for induced draft service in large industrial plants, central power stations, paper mills, sintering plants, etc. is presented in 6-pp Bulletin RT-100. Mechanical efficiency curve, dimensional data and diagrams included.

103 Positive Displacement Blowers — Horizontal and vertical blowers and gas pumps designed to automatically provide a metered quantity of oil-free air at constant volume, even against variable pressure, are described in Sutorbilt Corp.'s 12-pp Bulletin S59-H. Performance and dimensional data is given by means of charts and drawings.

Piping and Valves

104 Check Valves — Features and advantages of silent check valves with spring-actuated closing to prevent surge and hammer are detailed in this product bulletin of Combination Pump Valve Co. Photos and diagrams illustrate details of design and operation.

105 Hot Water Balancing Valve — Bulletin 204 describes a dual-purpose hot water balancing valve designed by American Air Filter Co., Inc., to do the work of two valves on return line of water coil. Explains built-in "memory" device and includes dimensional data and specification information.

106 Free Discharge Valve — Featured in 16-pp Bulletin 02B9206 by Allis-Chalmers Mfg. Co. is a free discharge valve designed to pass a controlled amount of water downstream for power requirements, flood control or draining. Detailed specifications are included along with photos of applications in water works, hydraulic plants, flood control.

107 Industrial Vent Pipe — Advantages and properties of Transite industrial vent pipe manufactured by Johns-Manville Corp. are detailed in 20-pp Bulletin TR-237A. Engineering data and dimensions are tabulated, couplings and fittings are illustrated, and data on jointing compounds, flexible fan connections included.

108 For Fire Lines — Advantages of asbestos-cement Transite pipe for fire protection systems in industrial plants are detailed by Johns-Manville Corp. in 8-pp Bulletin TR-253A. Performance characteristics are described and typical arrangement of plant fire protection system included, along with specification data.

109 Improved Pipe Wrap — Described by Plicoflex, Inc., in this 10-pp brochure are advantages of using laminated butyl rubber and plastic tape in combination with a butyl base primer as a corrosion resistant pipe wrap for protecting pipe lines, process lines etc. Gives full specifications on Plicoflex tape and shows some of its uses.

110 Flexible Metal Hose — Detailed information on all-metal flexible hose to convey gases, solids and fluids, for vibration control, and to compensate for motion or misalignment under high temperature, pressure, vacuum or abrasive conditions is presented in 20-pp Catalog ID-100D, Universal Metal Hose Co. Specifications and application photos, together with coupling recommendations are included.

Pumps and Compressors

111 Centrifugal Pumps — Multi-stage, opposed-impeller, centrifugal pumps to handle hot or cold water, hydrocarbons, chemicals, acids, condensates and similar liquids are featured Bulletin 140, Pacific Pumps, Inc. Included is a chart which graphically illustrates which components are interchangeable.

112 Pumping and Hydraulic Data — Definitions, formulae, testing, tables, charts and definitions useful in pumping and hydraulics are covered in 20-pp Bulletin EM-77 issued by Peerless Pump Div., Food Machinery and Chemical Corp. Includes facts on how to figure NPSH, pump efficiency, mechanical and electrical equivalents, and pipe friction loss chart, weir table, orifice charts.

113 Motor-Driven Compressors — Operating characteristics of The Cooper-Bessemer Corp.'s FM compressors featuring natural force balance are described in Bulletin 97. Contains cutaway models of unit, charts and diagrams, and specification tables.

Mechanical Power Transmission

114 For Power Transmission — T. B. Wood's Sons Co.'s line of mechanical power transmission equipment is presented in 8-pp Bulletin 23103. Products covered include variable speed drives of both motion and stationary control types, conventional v-belt and Ultra-V belt drives, timing belt drives, flat belt pulleys, flexible and rigid couplings, adjustable motor bases, ball bearing pillow blocks, flange and take-up units, solid and split sleeve pillow blocks, cotton-card drives, cotton cleaner drives, bushings.

115 Electromagnetic Drives — Illustrated and described by Westinghouse Electric Corp. in 12-pp Bulletin B-7875 are electromagnetic drives for conveyors, fans and pumps, winders, metal slitting and forming machines, paper mill machinery, and anywhere need for speed control exists. Operation and types of drives discussed.

116 Adjustable Speed Drive — Features and advantages of General Electric Co.'s Polydyne mechanical adjustable speed drives are covered in 16-pp Bulletin GEA-6806. Discusses principles of operation, configurations and features, and includes mounting positions, rating tables, and description of accessories.

117 Speed Reducers — Parallel shaft speed reducers which permit shafts to be arranged to suit specific drive requirements are featured in Link Belt Co.'s 36-pp Book 2719. Rating tables contain thermal and mechanical horsepower ratings for each input and output speed, and overhung loads, extended shafts and outboard bearings, dimensions and actual ratios are included.

118 Flexible Shaft Handbook — A simplified approach to the selection of flexible shafting through standard, pre-engineered, or custom-designed flexible shafts is offered in this 90-pp handbook issued by S. S. White Industrial Div. Describes advantages of flexible shafts, their function and applications, and includes tables, charts and drawings.

119 Flexible Cushion Couplings — Two types of flexible cushion couplings, one for high speed, high torque applications and another for attachment to flywheels of internal combustion engines, are described by Dodge Mfg. Corp. in 20-pp Bulletin 901. Includes engineering data, photos, dimension drawings and tables.

New and revised publications reviewed on these pages offer help on operating and maintenance problems. To order, use the handy Reader Service Cards provided on pages 103 and 104.

Refractories

121 Refractories Products — Described in Volume 4, Number 1 issue of Babcock & Wilcox Co.'s Refractories News is a line of refractory materials, including firebrick and ramming mixes. Specifications are given.

122 Plastic Firebrick — Bulletin 982 contains detailed information on J. H. France Refractories Co. plastic firebrick for use in all types of boilers and in spreader stoker arches and piers. Covers characteristics and application details.

Heating and Cooling

123 Tank Heaters — Described in 8-pp Bulletin 300, issued by Brown Fintube Co., are three types of tank heaters — vertically mounted, horizontally mounted and immersion type heaters. Applications, dimensions, heating surface and other specification data included.

124 Finned Tube Radiation — Presented in 16-pp Bulletin 460 of Modine Mfg. Co. is finned tube radiation for steam and hot water. Gives features, ratings and dimensional data for radiation with standard enclosures and with deluxe enclosures, as well as information on trim pieces and accessories and possible arrangements. Also shows flat-top covers for use where enclosures are not desired.

125 Heat Exchangers — Detailed information on heat exchangers for a variety of commercial and industrial hot water heating applications is presented in 24-pp Catalog 601 of Old Dominion Iron & Steel Corp. Includes construction details and engineering data, selection charts for all types of converters and instantaneous heaters, both steam to water and water to water heat transfer.

126 Heat Transfer Equipment — Featured in 32-pp Catalog 160 released by Young Radiator Co. is a line of heat transfer equipment, including radiators, heat exchangers, supercharger air coolers, industrial and oil field equipment and heating and air conditioning products. Includes complete product resume including installation photos.

127 Heating-Cooling Coil Uses — Applications of single and double embossed Panelcoil for heating and cooling are illustrated and described by Dean Products, Inc., in Data Sheets M12 and M13. Shows applications on storage and processing tanks, drums, troughs, ovens and other processing equipment.

Materials Handling

128 For Bulk Materials — Illustrated and described in 28-pp Bulletin 150A is Clark Equipment Co.'s line of tractor shovels, tractor dozers, tractor scrapers, and excavator cranes. Describes the power train package and illustrates components.

129 Cradle Idler — Detailed information on McNally Pittsburg Mfg. Corp.'s cradle idler and belt conveyor for handling all types of materials is presented in 16-pp Bulletin 660. Photos, dimensional drawings and capacity tables are included.

130 Car Shaker — Described in Link-Belt Co.'s 6-pp Folder 2745 is a one-man operated railroad car shaker which incorporates a low-frequency vibration shaker mechanism for economical unloading of hopper bottom cars. Applications are pictured.

131 Car Handling Systems — Various systems of handling railroad cars for loading such materials as coal, rock, gravel, etc. are described in Bulletin 760 by The McNally Pittsburg Mfg. Corp. Photos, dimensions, drawings and specifications give complete description of company's automatic loading systems, car hauls and car retarders.

Electrical

132 Substation Planning — How Allis-Chalmers Mfg. Co.'s Regu/Tran unit assembly provides greater load tap-changing flexibility, better service continuity and less maintenance cost is told in Bulletin 61B9695. Describes unit assembly.

133 Transformers, Substations — Features and advantages of Sorgel Electric Co.'s transformers and substations are detailed in 12-pp Bulletin 960. Information is provided on coil and core construction, insulation, capacity and sound levels.

134 Dry-Type Transformers — Selection and application information on General Electric Co.'s dry-type transformers is presented in 24-pp Bulletin GEA-6907A. Prices, dimensions and specifications for single- and three-phase general-purpose transformers, autotransformers, buck-boost transformers as well as for distribution and voltage-stabilizing transformers are included.

135 Silicone Rubber Insulation — Advantages and characteristics of silicone rubber insulated wire and cable are detailed in this 6-pp product bulletin issued by Dow Corning Corp. Typical applications are listed along with specifications.

136 Manual Motor Starters — Bulletin GEA-6358C, 12 pp, General Electric Co., describes a manual motor starter for fhp motors and another for integral horsepower motors to 7½ hp. Illustrations include photos showing construction features, dimensional diagrams and photos showing two basic forms for each type of starter: toggle and key operated for the fhp unit and toggle and push button for the other starter. Heater selection tables and prices are provided.

137 Magnetic Starters — Brochure 14-B2 of Furnas Electric Co. describes magnetic starters featuring unitized construction with all components front removable. Application and features of design described, with selection data.

138 Reduced-Voltage Starters — Eight-pp Bulletin GEA-6860A describes General Electric Co.'s full line of reduced voltage starters for starting squirrel-cage motors in all types of applications. Detailed selection data included.

139 Electrical Products — This 10-pp product guide of The Superior Electric Co. covers ratings and other essential technical data on variable transformers, automatic voltage regulators, electrical connectors, synchronous motors, packaged transformer primaries, line correctors, loading reactors, a-c, d-c power supplies.

140 Wireways and Enclosures — Featured in 16-pp Catalog 159-D, issued by Keystone Mfg. Co., is a line of wireways, fittings and enclosures designed for applications where wiring must be protected against dirt, dust, oil, water and coolants. Includes dimensional drawings and detailed specifications.

141 Cellular Floor Raceways — Featured in 8-pp Catalog 60, Wheatland Electric Products Co., is a cellular floor feeder raceway. Contains suggested architectural specifications for cellular floor feeder raceway, cross-section drawings, information on access unit spacings and lengths, assembly fittings, junction units.

143 Industrial Power Systems — Principles of planning industrial power distribution systems for safety, reliability and economy while retaining flexibility and provisions for future expansion are outlined in General Electric Co.'s 48-pp Bulletin GEA-7139. Chapters cover choosing voltages, short circuit calculations, protective relaying, selection of unit substations, power factor corrections.

144 Transistorized D-C Supplies — Eight-pp Bulletin GED-4184 discusses General Electric Co.'s standard line of precision-regulated, transistorized d-c power supplies for a wide variety of applications in utilities and industry. Contains photos and charts showing specifications.

Communication

146 For Control, Communication — Featured in 36-pp Bulletin S-100 C1, released by Edwards Co., Inc., is a line of control, communication and protection equipment for industrial and commercial buildings. Includes detailed specifications on annunciators, bells and buzzers, fire alarm equipment, push buttons and transformers, and other equipment.

147 Audible Signal Equipment — Audible signal devices and the types most suitable for specific noise level areas are featured in 16-pp Bulletin K released by Benjamin Div., Thomas Industries, Inc. Diagrams, specifications, mounting methods, decibel output charts and construction details are included.

Automation, Instruments, Controls

148 Receiver Gages — Eight-pp Catalog 520, issued by United States Gauge Div., American Machine & Metals, Inc., describes dial indicating receiver gages designed to indicate values transmitted by pneumatic signal from remote locations. Gives specifications and contains information on materials, dials, ranges, case styles and sizes.

149 Thermal Systems — Twelve-pp Specification Sheet S-690-1a, Minneapolis-Honeywell Regulator Co., covers bulbs, tubing and fittings for filled system thermometers. Gives detailed information on sizes, lengths, materials for bulbs and tubings of gas, mercury and vapor-actuated thermal systems, as well as a vibration-resistant gas-actuated thermal system which uses miniature bulbs.

150 Static Control — Eight-pp Bulletin GEA-6578A, General Electric Co., describes features and applications of static control for machinery and process control without moving parts. Basic logic elements are covered, components described, and installation details included.

151 Electric Control Systems — Solid-state electric control systems designed to produce process variable outputs in accordance with desired or set point conditions are described in Bulletin E74-1 by Bailey Meter Co. Discusses signal range, measuring signal initiators, control action units, selector stations, power units, electric drive, pneumatic drives and valves, and electric-to-pneumatic conversion.

152 Pneumatic Computer — Eight-pp Catalog 53CR1000 describes Fischer & Porter Co.'s pneumatic computing relay for squaring, square-root extraction, ratio setting, multiplication and division. Operation and design features are described and specifications included.

154 On-Stream Composition Analysis — Principles upon which continuous, non-contacting measurement of fluids in pipes is achieved are discussed by Industrial Nucleonics Corp. in 12-pp Bulletin CA-860. Describes composition analysis systems using radioisotopes and includes photos and drawings, and detailed application data.

155 Armored Multitube — Detailed information on spirally cabled tubes for instrument and control systems is presented in 12-pp Bulletin 960 by Crescent Insulated Wire & Cable Co., Inc. Various types of tubing, the protective interlocked armor, types of corrosion-resistant sheaths, installation and instructions included.

more Current Catalogs page 103

Hall Industrial Water Report

VOLUME 8 DECEMBER 1960 NUMBER 6

Pouring Oil on Water

Oil will quiet angry waters. But when oil is inadvertently introduced to boiler feedwater it can cause plenty of trouble with blistered tubes and carryover. Other contaminants in makeup water or condensate can be equally or even more dangerous. Thus, for good boiler operation it is essential to keep boiler feedwater free of significant quantities of contaminating materials.

It is part of the Hall engineer's job to help you locate possible sources of contamination before difficulty occurs. When, in spite of all precautions, something troublesome does get into the boiler feedwater, he is prepared by his training and experience to help you to locate the source quickly. He is also prepared to be of service on all your water problems whether they be in the boiler house, in process, in cooling systems or in waste disposal.

Silica Trouble

An unusual condition caused production losses in an Eastern paper mill. Makeup water for the high-pressure boiler was clarified with aluminum sulfate and activated silica and then deionized. When upsets occurred in the clarifier, colloidal silica passed through the deionizer and into the boiler. This resulted in high boiler water silica concentration, which necessitated boiler operation at lower than normal load. Hence, loss of production.

Hall engineers studied clarifier operation by means of numerous jar tests. These showed that substituting a non-siliceous Hagan coagulant aid for activated silica would produce satisfactorily clear water with complete elimination of silica carryover. A bonus was a more than twenty percent increase in anion exchanger capacity due to the decrease in the silica content of the clarified water.

Tracing Condensate Contamination

Foaming of the boiler water at a midwest manufacturing plant indicated that contamination of feedwater was occurring. A further indication of contamination was difficulty in testing—when an alkaline oxidizing reagent was added to samples for oxidation of organic matter in the phosphate test, the water turned black.

The condition in the phosphate test was checked by Hall field engineer Earl Hoehn. He discovered that he got the same black color when he added the reagent to some condensate samples. He then used this unusual but timely test to trace the contamination to its source. It turned out to be nickel plating and metal cleaning solutions, which were getting into the condensate through small leaks in the steam heating coils in the solution tanks. The reaction between the nickel and the alkaline oxidant was producing black nickelic hydroxide.

Boiler Cleaning Problem

Many of the compressors and pumps in a New York State hospital are driven by reciprocating engines. The oily exhaust steam is used for space heating and heating hot water. The condensate is then returned to the boilers.

Because of the lack of oil removal equipment there is so much oil returned to the boilers at times that some can be seen floating on boiler water samples. Oily sludge accumulates and boiler cleaning is a real problem. A turbine quickly becomes fouled so badly it is valueless. The only effective procedure the operating men discovered was swabbing out the tubes with rags soaked in a solvent.

When Hall field engineer Sam Dilcer learned about the problem he tried boiling out the boilers with a strongly alkaline metaphosphate-metasilicate (Calgonite) solution. This is usually effective but in this case the amount of oil in the sludge deposits was so great the boilers remained dirty. Wire brushing was necessary and the wire brushes became fouled so rapidly they had to be rinsed in a solvent after passing through one tube.

Dilcer then recommended boiling out with Calgonite plus a cleaner of the emulsified hydrocarbon type (Calgon Emulsion Cleaner). This left nothing to be desired. Wire brushes drawn through the tubes remained clean. The plant engineer told Dilcer, "You licked our problem with the boilers so we'll have to find something else to keep you busy."

New Booklet Available

A new 24-page booklet describes the many ways industry can use Hall Laboratories industrial water consulting services.

For your copy, write on your letterhead to:

HALL LABORATORIES
HAGAN CENTER, PITTSBURGH 30, PA.
Consultants on Procurement, Treatment, Use and Disposal of Industrial Water

DIVISION OF **HAGAN** CHEMICALS & CONTROLS, INC.

For more data circle 520 on Post Card

POWELL PRESSURE SEAL VALVES

Fig. 19084—Steel Pressure Seal Non-Return Globe Valve for 900 pounds W.P. Spur Gear operated. Can also be furnished with bevel gears if required.

Fig. 11865—Steel Pressure Seal Horizontal Lift Check Valve for 1500 pounds W.P. Powell streamline design assures maximum flow through with minimum pressure drop and turbulence.

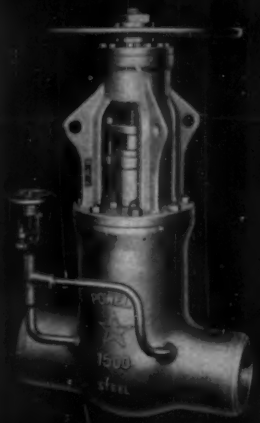

Fig. 11313—Steel Pressure Seal Gate Valve, with By-pass, for 1500 pounds W.P. By-pass valve is Powell Integral Bonnet Angle Valve, Fig. 1333A, for 1500 pounds pressure.

Performance makes the world of difference

Keeping modern industry's constantly mounting temperatures and pressures in check demands rugged, dependable controls. Powell Pressure Seal Valves have proved equal to this task in more than 10,000 installations the world over. Precision-built, precision-tested, leak-proof, with many exclusive design and construction features—Powell Pressure Seal Valves are available in gate, globe, angle and check patterns for 600 to 2500 W.P., and special working pressures upon request. Many are in distributor stock or factory stock for quick delivery.

If you have a flow-control problem involving high temperatures and high pressures, your nearest Powell distributor has the solution. Talk to him. Or call us direct for complete information and illustrated literature.

Powell . . . world's largest family of valves

THE WM. POWELL COMPANY • DEPENDABLE VALVES SINCE 1846 • CINCINNATI 22, OHIO

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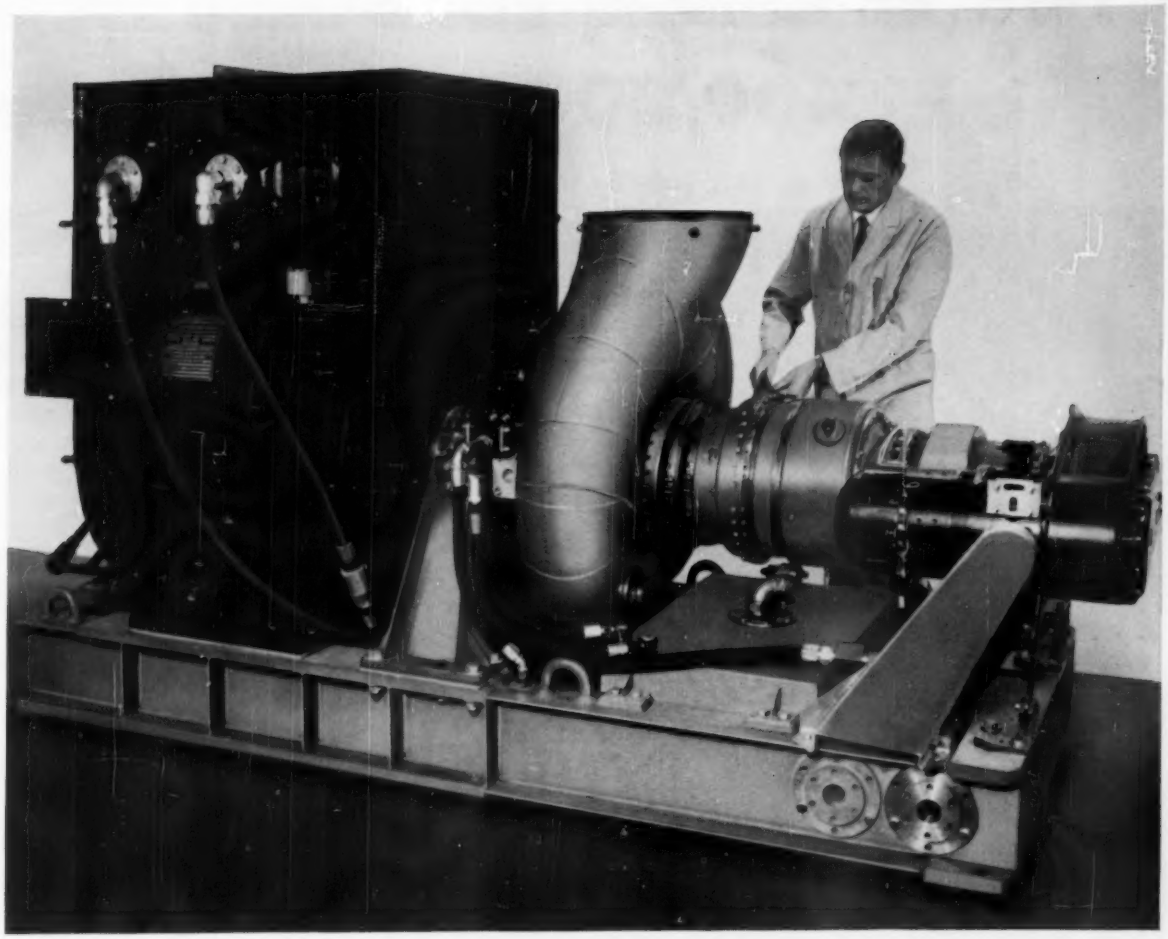

750 KW!

Electrical generator driven by new Solar Saturn *industrial gas turbine offers unequaled fuel efficiency, outstanding performance*

SOLAR'S REMARKABLE NEW 1100 hp industrial gas turbine sets new standards of performance as a power source for marine and industrial generators. The engine is extremely lightweight, averaging 1/10th the weight of conventional engines of similar horsepower. It occupies only 51 cubic feet. It starts instantly (an advantage of significant importance in generator applications). And it takes full load without laboring, even after long periods of standby service. In addition, Solar's *Saturn* industrial gas turbine offers fuel efficiency unequaled in its field.

As a dependable power source for generators and compressors, as a propulsion unit for high-speed boats and in other applications... Solar gas turbines are saving time and money. For information about Solar's family of 50 to 1100 hp gas turbines, write to Dept. H-183, Solar Aircraft Company, San Diego 12, California.

SOLAR
AIRCRAFT COMPANY
A subsidiary of International Harvester Company

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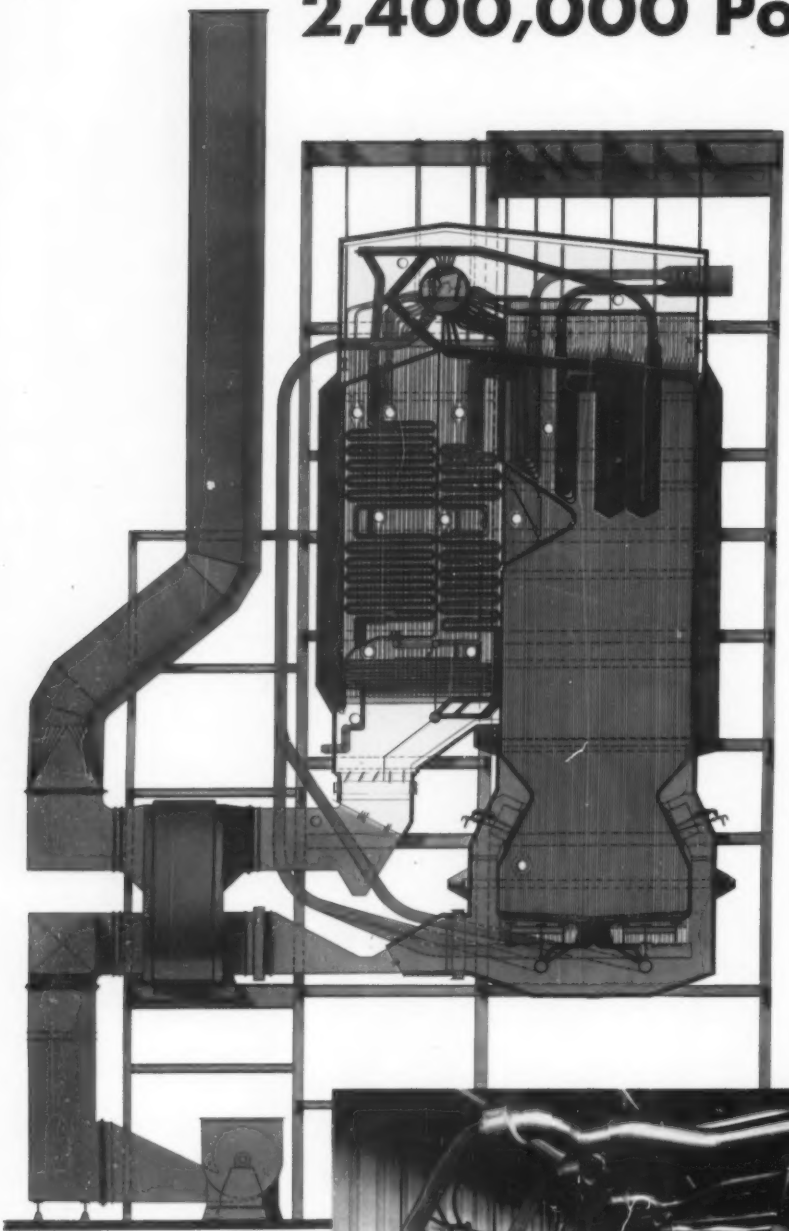
Two RILEY TURBO FURNACE 2,400,000 Pounds of Steam



At the new North Lake Steam Electric Station the first of two Riley Turbo Furnace Reheat Boilers recently purchased by Dallas Power & Light Company is now on the line. Distribution of furnace gases is exceptionally uniform with minimum metal temperature variations across the full widths of reheater and superheater. Superheat and reheat temperatures are maintained over required control ranges. Boiler operates continuously at design rating for long periods. Extreme ease of operation with minimum operating personnel results from all burners being located for opposed firing on *one* level. Steam temperature is mainly controlled by automatic dampers located below the economizers.

Several other Southwestern Public Utilities have installed the Riley Turbo Furnace Boiler because its design and method of firing permits quick, easy and low cost conversion from natural gas to other fuels.

ENGINEERING DATA

Capacity — 1,200,000 lbs/hr
Pressure — 2125 psig
Superheat — 1005F,
Reheat — 1005F
Fired by Natural Gas, Oil

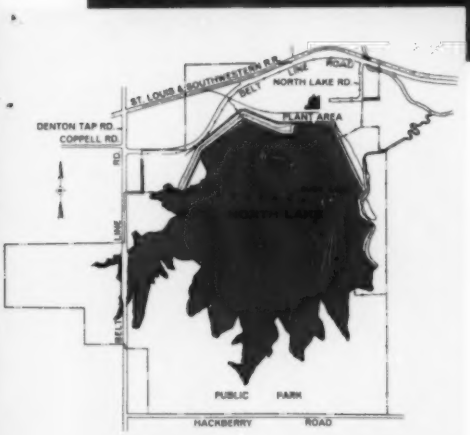
EBASCO SERVICES, INC.
Consulting Engineers

One of two firing aisles located on opposite sides of the furnace shows ten Riley Directional Flame Turbo Furnace Burners. The Turbo Furnace single level burner arrangement minimizes operating supervision and maintenance.

A careful survey of your plant by a qualified consulting engineer could show ways of making substantial savings in power costs.

Reheat Boilers will produce for *Dallas Power & Light Company*

NORTH LAKE STEAM ELECTRIC STATION



North Lake is an 800 acre man-made lake constructed for cooling water by Dallas Power & Light. Most of its area is open to public boating and fishing. Here is an unusual use of a private power company's facility. Much credit is due to Dallas Power & Light Company for imaginative and public spirited foresight.

RILEY

STEAM GENERATING & FUEL BURNING EQUIPMENT

RILEY STOKER CORPORATION, WORCESTER, MASSACHUSETTS.

Sales Offices:
Boston, Charlotte, Chicago, Cincinnati, Cleveland, Detroit, Houston, Jacksonville, Kansas City, Los Angeles, New Orleans, New York, Philadelphia, Pittsburgh, Portland, Salt Lake City, San Francisco, St. Louis, St. Paul, Seattle, Syracuse.

HOFFMAN

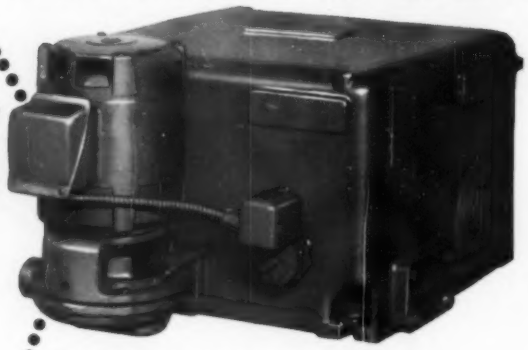
CENTRIFUGAL-TYPE

PUMPS

Unequalled Quality

Your Best Buy

CONDENSATION TYPE "HCS" SINGLE UNIT



Single and Duplex Units
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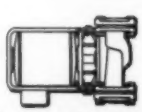
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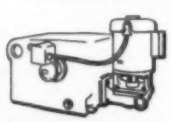
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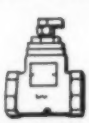
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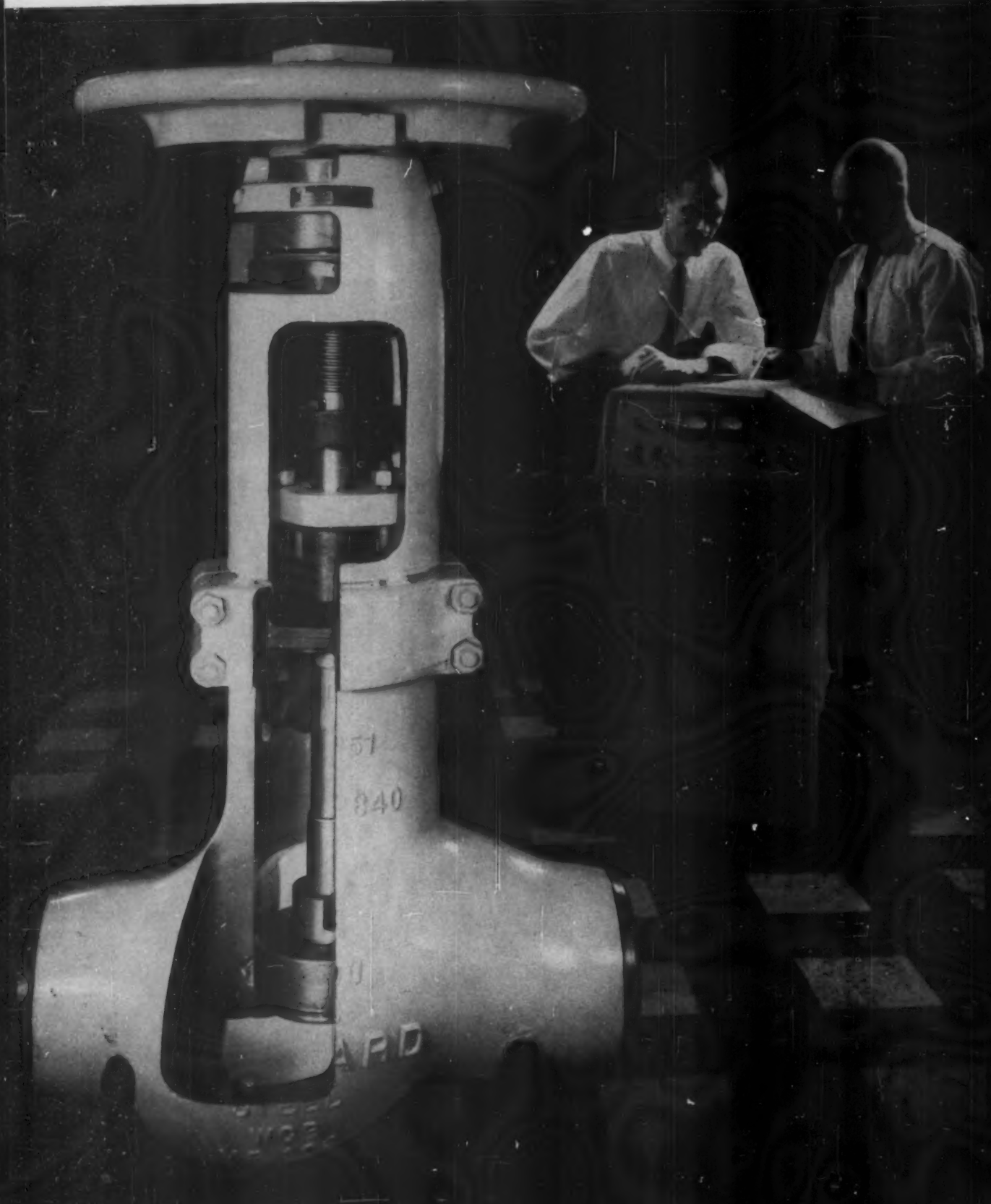
The Story of Edward Research



and the Pressure-Seal* Valve

The introduction, in 1945, of commercial steel valves with pressure-seal bonnet joint construction was a significant advance in the art of building large high-pressure steel valves. The new pressure-seal construction eliminated massive flanged bonnet joint connections and made it possible to seal the valves permanently at high temperature. These advantages were immediately apparent to users everywhere. But bonnet joint leakage problems developed on the new valves in service. And Edward engineers soon became convinced that the original 45° pressure-seal gasket design used by Edward and others required improvement. Here's the Edward pressure-seal redesign story:

INITIAL TESTING—Edward engineers began their studies on leak problems in 45° gasketed pressure-seal valves by determining under what conditions the valves were most likely to leak. It was discovered that when sealing areas were thoroughly degreased and tested with air, the pressure seal would leak at all pressures above 10 psi. In addition, minute imperfections in the sealing area of the valve body bore were preventing intimate gasket contact and contributing to leakage. Edward engineers found that a broader area of contact between gasket and bonnet and between gasket and body bore would also reduce leakage. Further investigation showed that a gasket plating material softer than the silver plating previously used would be helpful in achieving better contact in the sealing area.

To obtain more gasket sealing area, experiments were conducted on gaskets with angles from 45° down to 17°. Over a period of several months, tests were made with 25 different combinations of gasket and bonnet angles and various gasket plating materials. Assembled valves were tested for tightness with air pressures ranging from 10 psi to 2160 psi, and at temperatures up to 1000 F for extended periods. And tests on ease of valve disassembly (an important user consideration) were made with each gasket combination.

TEST CONCLUSIONS—At the end of their extensive testing program on the pressure-seal design, Edward engineers were able to draw these conclusions:

1. 45° gaskets, which showed no leak on water tests, leaked air at similar pressures.
2. No gasket of any design, either plain or with a plating of 100 Brinell or harder, would seal air when assembled unlubricated.
3. The best sealing under test resulted with a 25° gasket angle which was 1° more acute than the bonnet angle.
4. Gaskets of 25° angle actually tripled the sealing surface area.
5. A stainless inlay in the valve body bore sealing area substantially improved gasket-to-body contact and provided a corrosion-resistant surface.
6. Gaskets of 25° angle, plated properly with a malleable coating, gave perfect air or steam sealing at all temperatures, whether assembled dry or with a lubricant.

NEW VALVE DESIGN—As the result of their tests, Edward engineers designed the completely new pressure-seal valve with 25°-65° joint (see diagram below). This change in gasket angle, with an increase in sealing surface area, and the addition of a special corrosion-resistant malleable coating, brought an end to bonnet joint leakage in Edward pressure-seal valves. And, since 1953, thousands of Edward pressure-seal valves have been installed in a great variety of services *without a single case of failure reported to date.*

The story of Edward research and the pressure-seal valve is typical of the kind of research progress and product leadership you can expect from Edward Valves. Edward builds a complete line of forged and cast steel valves from ¼" to 18" for industrial, marine, petroleum and technological services. For more detailed information, contact your Edward Representative, or write Edward Valves, Inc., 1202 West 145th Street, East Chicago, Indiana. Subsidiary of Rockwell Manufacturing Company. Represented in Canada by Lytle Engineering Specialties, Ltd., 438 St. Peter Street, Montreal.

*Patented

EDWARD STEEL VALVES
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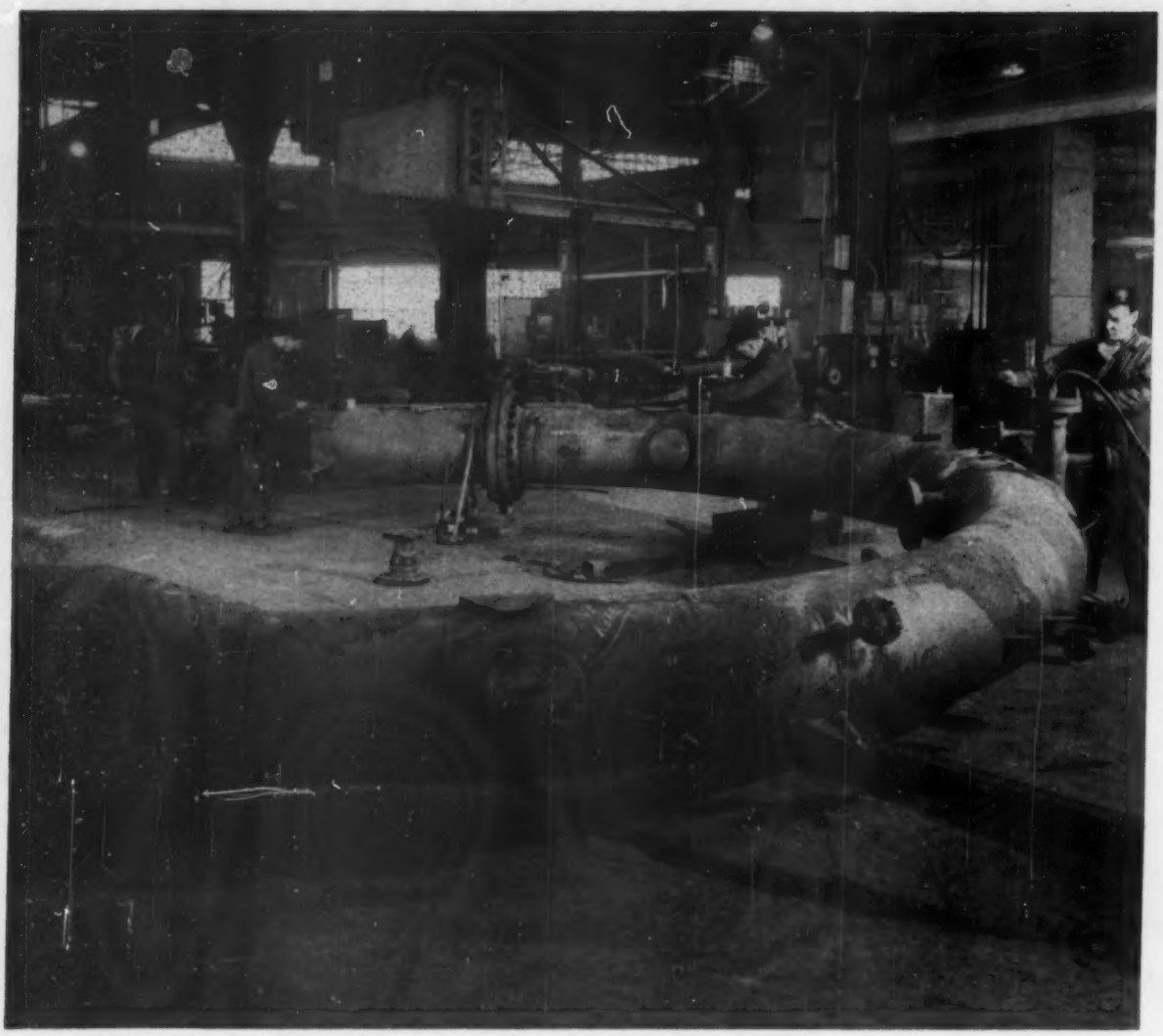
P. J. DUKES, product development engineer, and D. MacGregor, works manager, are shown with helium leak detector used in testing pressure-seal valve joints.

SPECIAL GAS-FIRED FURNACES were used in temperature testing of new pressure-seal valve design. Furnaces heated valves up to 900 F for 24 hour periods. Pressure was maintained with hydro-pneumatic pumps.

NEW 25° GASKET DESIGN



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ATOMICS

A section of POWER ENGINEERING covering current and forthcoming developments in the field of Nuclear Power throughout the world

ANDREW W. KRAMER

Editor

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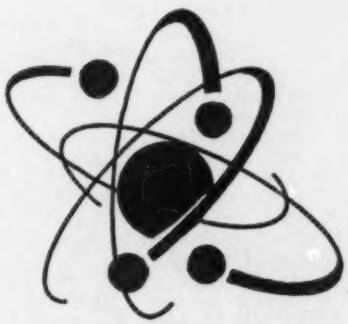

CHEERFUL REPORT

THE RECENTLY PUBLISHED REPORT of the Technical Appraisal Task Force of the Edison Electric Institute on Radioactive Waste Handling in the Nuclear Power Industry is the most cheerful analysis of the radioactive waste disposal situation that has come to our attention. According to the conclusions of the EEI Task Force, the relatively insignificant radiation coming from luminous dials and television sets will probably be greater than the average radiation from nuclear power stations in the United States during the next several decades. In fact, the study points out, even if world-wide nuclear power operations increase rapidly, their average radiation will be far less than that from natural sources, such as cosmic rays and minerals in the earth, and much less than radiation from medical and dental procedures involving x-rays and radioisotope treatments.

In view of the widespread apprehension concerning the dangers of accumulating radioactive wastes, the over-all conclusions of the EEI report are encouraging indeed. Much of the apprehension surrounding the radioactive waste disposal problem, as it is related to the nuclear power industry, stems from the fact that the waste disposal problem is part of the overall problem of radiation control which is highlighted by the controversy concerning fall-out of radioactive debris from nuclear weapons. As the report indicates, however, the radioactive waste problem as related to nuclear electric power generation appears to be a finite and manageable one and is different from the fall-out problem. There are at present only two principal sources of artificial radioactive materials: the explosion of nuclear weapons and the operation of nuclear reactors. In general, radioactive materials produced by weapons have been dispersed to the environment, while those produced in reactors are stored under controlled conditions. Over the past 15 years more than 70 million gallons of such wastes from the processing of spent plutonium production fuel, currently containing in the order of a billion curies, have been placed in large underground tanks at the AEC's Hanford and Savannah River plants. These tanks now have a total capacity of 110 million gal. At present such wastes are being produced at a rate of about 5 million gal a year. Compared to these quantities, it is estimated that by 1980 an accumulated total of 1 to 10 million gal of such wastes may have been generated in the U. S. from nuclear power, and the production rate may be in the order of a million gal per year. By the year 2000, the accumulated total might approach 100 million gal.

In other words, the EEI report concludes that the amount of radioactive wastes from operation of U. S. nuclear power plants will not exceed for several decades that which has already been produced and successfully handled in U. S. atomic weapon production facilities.

Andrew W. Kramer

Hot Fuel Elements Simulated in Reactor Studies

When the Allis-Chalmers Nuclear Power Department decided to experimentally determine the heat-transfer characteristics of the fuel elements, they were faced with the problem of how to heat them. Here two of the A-C nuclear engineers tell how it was done

By B. E. NEVIS and C. E. KLOTZ
Nuclear Power Department
Allis-Chalmers Mfg Co, Greendale, Wis.

IN THE DESIGN of the Pathfinder (ATOMICS, June '60, p. 50) atomic power plant, one problem facing reactor designers was the determination of the heat transfer and fluid flow characteristics of boiler and superheater fuel elements which operate at heat fluxes ranging from 70,000 to 500,000 Btu/hr-ft². In particular, the following information was needed:

1. Two-phase pressure drop and steam void distribution in the boiler elements.
2. Surface temperature and maximum allowable heat flux in the boiler and superheater elements.
3. Pressure drop in the superheater element.

To obtain this design data, a test loop was designed and is now in operation after successfully completing its shakedown tests.

The first question to be answered before this facility could be designed was: "How many fuel elements were to be tested at the same time? Should the facility be large enough to test a full core, a half core, one fuel element, one-half a fuel element, or a single coolant channel?" After careful consideration it was decided to test partial fuel element assemblies and later one full scale boiler element and one superheater element. By varying the power out of the element and the flow conditions, any of the elements in the core could be simulated.

This decision presented another problem. One boiler element and one superheater element do not constitute a critical mass; that is, such an arrangement will not support a self-sustaining nuclear reaction. This eliminated nuclear fission as a means of generating heat in the test facility. Several methods of generating heat were investigated, such as combustion of gases in the elements, circulating externally heated liquid metals or gases through the element, and electrical resistance heating.

Use of hot gases was eliminated because their low heat capacity made it practically impossible to get the required range of heat fluxes. Liquid metals also were not feasible because of the safety hazard presented by having them in close proximity with the water, and control of these systems would be difficult.

Electrical resistance heating had none of these disadvantages but did present problems of measuring temperatures in an electrical field, and in designing the element such that its electrical resistance and the electrical power source characteristics were compatible for generating the required amount of heat. These problems were resolved as follows:

A. SHOULD ALTERNATING OR DIRECT CURRENT BE USED? A-c heating

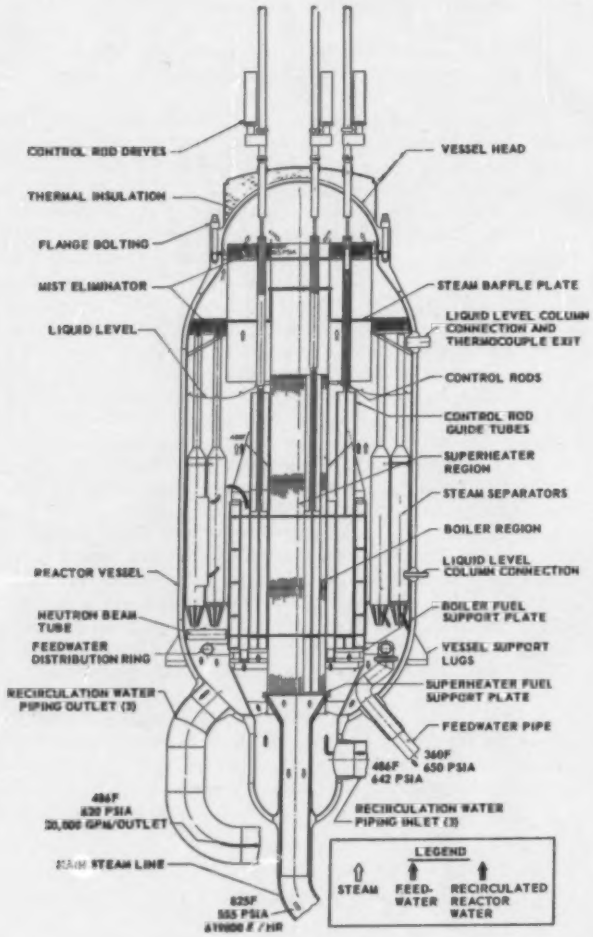

Fig. 1. Cross-section of the Pathfinder reactor showing the centrally located superheater surrounded by the boiler region. Many questions concerning the design of this reactor were solved by the heat-transfer studies on the test loop

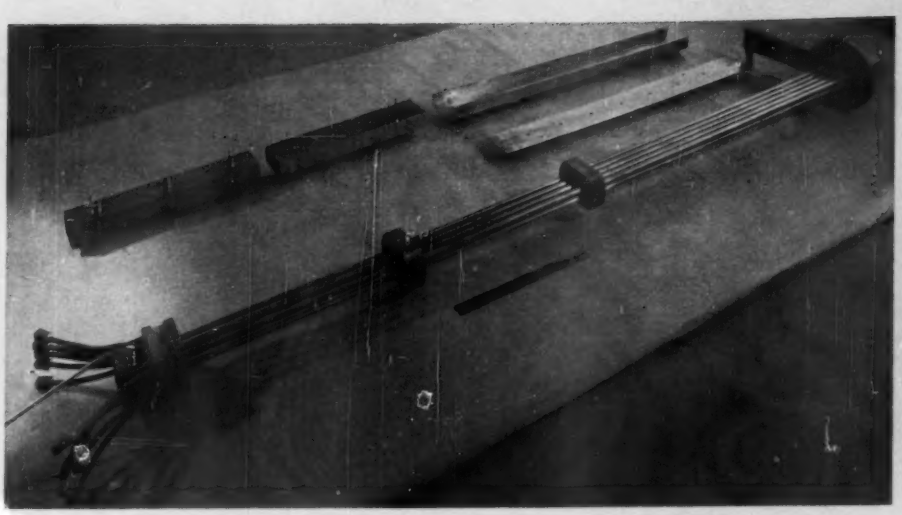

Fig. 2. View of the fuel element. Resistance heating simulates fission when high direct current is passed through the rod walls. Note that variable axial loading is simulated by using six rods in the first section, eight rods in the second, and ten rods in the last section

causes temperature measurement errors due to a fluctuating magnetic field that causes an induced emf in the thermocouple. Direct current heating causes temperature errors only due to an impressed emf on the thermocouple. If ungrounded thermocouples are used, the impressed emf effect can be eliminated. Hence, if d-c heating is used, temperatures can be read with no error since there is no induced emf. In addition, it has been stated that a-c heating may affect the bubble growth rate and burnout point. Although there is no definite proof of this, d-c heating would preclude this possible effect.

B. SHOULD A POWER SOURCE WITH A HIGH VOLTAGE (>75v) –LOW CURRENT CHARACTERISTIC OR A SOURCE WITH A HIGH CURRENT-LOW VOLTAGE (<75v) CHARACTERISTIC BE USED? High voltage sources demand a high resistance heating element and low voltage sources demand a low resistance element. Investigation of test element designs employing both types of sources revealed that in general low voltage sources allowed simpler element design. For instance, in high voltage design of an aluminum, nickel, or stainless steel rod, a heating element had to be placed in the rod and electrically isolated from the rod. In low voltage design the rod itself carries the current, the heat being generated in the rod walls. Figure 2 shows a typical test element for a low voltage source. The current passes through the rod walls. Imagine the complexity of design if individual resistance heaters had to be placed in each rod. It appeared, therefore, that the best type of power source would be a high current–low voltage d-c source.

C. WHAT TYPE OF D-C POWER EQUIPMENT SHOULD BE USED? The low voltage characteristic at a required power of 16 to 1800 kw eliminated conventional d-c generators. The choice had to be made between rectifiers and unipolar generators. The unipolar generator was chosen because of smaller space requirements and greater ease of control, Fig. 3.

After the method of heat generation was determined, the loop's size, flexibility, method of measuring the steam generated, materials of construction, and general flow path were chosen. These characteristics were as follows:

1. Both boiler and superheater fuel elements could be tested at the same time.
2. Boiler fuel element tests could be run using either natural or forced circulation of the coolant.
3. The quantity of steam produced could be measured directly.
4. The water and steam flow path would be the same as in the reactor.
5. Instrumentation and equipment control would be such that fuel elements generating from 25 to 1800 kw of heat at water flow rates from 15 to 600 gpm could be tested.

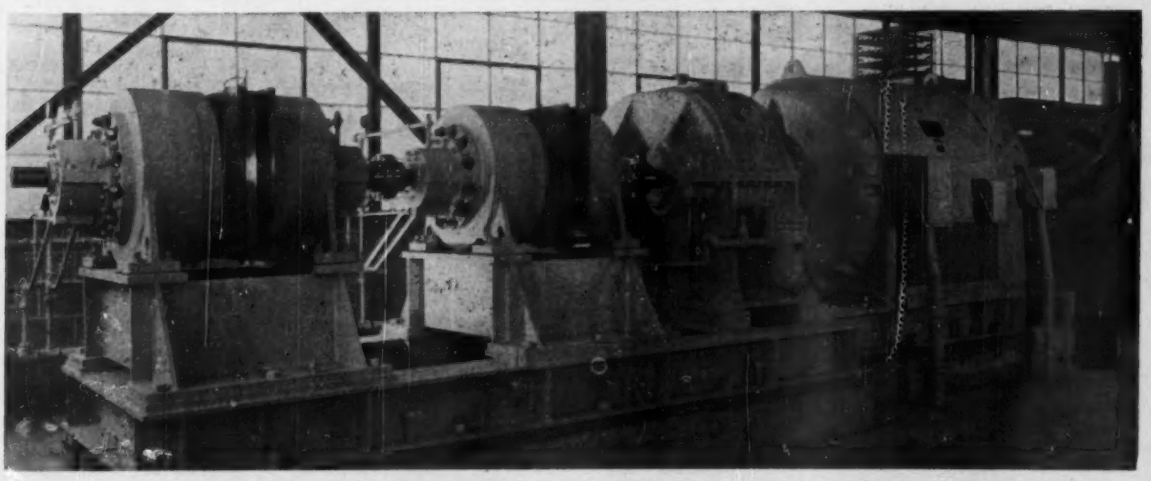

Fig. 3. Power for heating the test sections was supplied by two Allis Chalmers d-c unipolar generators, each rated at 60,000 amp, 30 v. Voltage can be varied continuously from 0 to 30 v. The generators can be connected in series or parallel, and each can be controlled independently. A 2000-hp, 1200-rpm synchronous motor drives the generators through a 6:1 speed increaser

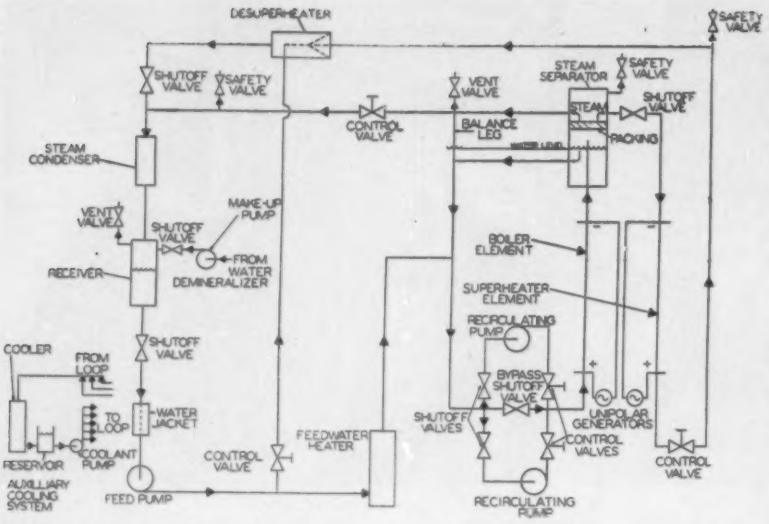

Fig. 4. Diagram of the test loop. The design of this system enables engineers to test both boiler and superheater fuel elements at the same time. Either natural or forced circulation can be used to test the boiler elements, and the quantity of steam can be measured directly

6. Boiler and superheater elements could be tested at pressures up to 1500 psi and temperatures up to 600 F and 1200 F respectively.

7. Stainless steels 304, 316, and 347 would be used to permit the use of demineralized water without employing a by-pass demineralization system to maintain water purity.

Loop Flow Path

A system designed to accomplish the first four of these characteristics can be seen by referring to the loop schematic, Fig. 4. In the case where a boiler test is being run, water is pumped through a simulated boiler fuel element (test section) where the water is heated by the test section and some of it is changed to steam. The steam and water are separated in a gravity-type vertical steam separator. The water is recirculated through the test section. The steam is throttled to one-half of its upstream pressure, condensed, heated to the recirculating water temperature, and returned to the recirculating water.

In the case where a superheater test is being run, the steam generated in the boiler test section is passed through the simulated superheater fuel element where the steam is superheated by the test section. The steam is then throttled to one-half of its upstream pressure, desuperheated (to protect the condenser), condensed, etc. The desuperheater gets its cooling water by bleeding part of the feedwater.

Loop Equipment

The last three characteristics can best be shown by indicating the ratings of the equipment and instrumentation used in the loop. This information is presented in the accompanying tabulation. Keep in mind that all parts of the equipment and instruments which come in contact with the water or steam are made of SS 304, 316, or 347.

Loop Instruments

The loop is instrumented to supply necessary data to calculate the characteristics of the test sections. The control panel is shown in Fig. 5. The panel layout philosophy was to place all control devices within easy reach of the operator and at the same time have the instrument that indicated what was being controlled within readable range of the operator. For the most part, control devices are on the horizontal section of the panel and instruments on the vertical section.

Grounded sheathed thermocouples are used to measure temperatures in the circulating water, the saturated steam, the superheated steam, the condensed steam, the water into the feed pump, the water out of the feedwater heater, and the unipolar bearings. Ungrounded sheathed thermocouples are used in the test sections eliminating the effect of an imposed emf at the thermocouple junction due to voltage drop along the test section.

The steam voids along the boiler test sections are measured by a gamma ray technique. A gamma ray beam is passed through various parts of the test section and into a scintillation counter. The number of gamma rays of any given energy which get through with no energy loss are directly related to the volume of steam per volume of steam-water mixture at that point in the test section. The gamma rays are counted and recorded by means of a scintillation probe, single channel radiation analyzer, count rate meter (or scaler), and a strip chart recorder. The gamma ray source and scintillation detector are positioned along the test section by means of a remotely controlled positioning rack. Gamma ray sources used are Cesium 137 and Thulium 170.

The power input to the test sections is determined by measuring the voltage drop across the sections and the current going through the sections. The current is measured by either a saturable reactor or a shunt.

Although the control of the loop is manual, it can be run easily by three men. The loop was heavily

Characteristics of Equipment Used in Test Loop

EQUIPMENT	RATING	NOTES
Unipolar generator	60,000 amp, 30 v, each	Can be varied continuously 0-30 volts. Each is controlled independently by field rheostat. Can be used in series or parallel
Motor (driving generators)	2000 hp, 1200 rpm synchronous	Drives through a 6:1 speed increaser
Large recirculating pump	600 gpm against 200 ft head	1500 psi, 600 F operation
Small recirculating pump	75 gpm against 72 ft head	1500 psi, 600 F operation
Feedwater pump	Continuous control 4.5–25 gpm at 0–1500 psi reciprocating	Driven by remotely controlled variable speed motor
Make-up pump	5 gpm at 0–800 psi reciprocating	
Receiver	800 psi, 518 F	ASME unfired pressure vessel code
Steam separator	1500 psi, 518 F	ASME unfired pressure vessel code
Steam condenser	10,000 No. 1 hr of steam at 800 psi, 7500 No. 1 hr of steam at 300 psi	Horizontal, air-cooled, finned-tube
Feedwater heater	100 kw heaters, 1500 psi at 600 F	Three heaters are independently controlled
Desuperheater	5000 No. 1 hr of 800 psi, 1200 F steam to 600 F using one gpm of cooling water at 518 F	
Control valves	2 in.	Saturated steam and superheated steam
	¾ in.	Desuperheater cooling water
	6 in.	Large recirculating pump
	1½ in.	Small recirculating pump

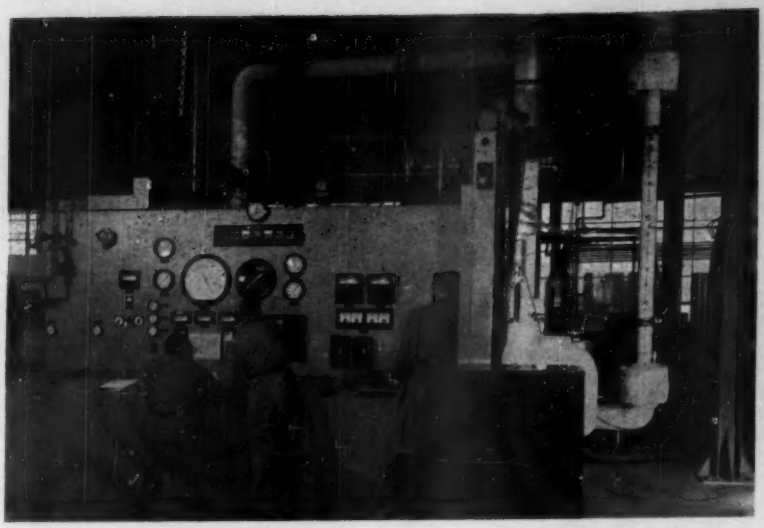

Fig. 5. The test-control panel. The audio-visual annunciator is shown at the top. Directly below is saturated steam flow meter. Pressure gages, steam flow meter, liquid level indicators and a 24-point temperature indicator are all conveniently located. At the far right are two burnout indicators that shut down the unipolar generators if signal from thermocouples exceeds a set point

insulated to reduce heat loss and hence heat-up time. For example, it takes three hours to hot-pressurize the loop from 0–600 psi while supplying only 25 thermal kw to the system.

Loop Shakedown Tests

After the loop was built it underwent a series of shakedown tests. First, the loop was cleaned with acetone and flushed out several times with distilled water. It was then cold-pressurized to 2250 psi, checked for leaks and then insulated. All of the equipment was run cold at atmospheric pressure and malfunctions corrected.

A dummy test element was then placed in the boiler section. The dummy consisted of a 4-in. schedule 80 flanged stainless steel 304 pipe 10 ft 6½ in. long, with two copper electrodes silver-soldered to the outside surface of the pipe. The dummy was electrically insulated from the rest of the loop and tied electrically to the unipolar generators.

The loop was filled with demineralized water, and by generating heat in the dummy, the loop was degassed and hot-pressurized to the Pathfinder reactor operating conditions of 600 psi and 489 F. The equipment was run under these conditions and malfunctions corrected. When all the equipment was made to run satisfactorily and the lab personnel had become sufficiently acquainted with the running of the loop, the dummy test element was removed and the testing of the reactor boiler and superheater test sections was started. END

The Economics of Nuclear Power

Here is a short but very logical discussion of nuclear versus conventional power costs that leaves little room for doubt as to the future of nuclear power development

By J. E. MAIDER
Manager, Atomic Power Equipment Department
General Electric Company, San Jose, California

WHEN ONE READS our leading newspapers and popular news magazines, a confused impression of the peaceful atom is gained. In one place it may be portrayed as a tremendous boon to mankind, providing a limitless source of energy for all time. In another article, the pessimists state it will never contribute more than a trickle of useful electric energy to our needs. In still another, the supposed potential dangers of the use of the atom for power generation are portrayed with the lurid details worthy of the promotion of a third-rate movie. It's no wonder that the average citizen has little or no concept of the place of atomic power, when even the "experts" can't agree.

Let's begin by going backwards, to the time when atomic power was only a thought in the minds of some far-thinking scientists and engineers. The nation's electric utilities were buying steam boilers and electric machinery then, just as they are today, and building them into electric generating plants. The economics governing the purchase of a new piece of generating equipment were the same then as they are today. An electric utility company participates in a so-called "regulated" industry: in return for the right to an exclusive franchise to serve a given area without competition from another company, it must generally operate in accordance with rules prescribed by a state public service commission. It is easy to understand why this sort of operation is necessary in the power industry, since competition between power companies would mean wasteful duplication of generating facilities, power lines, distribution systems, and all the equipment necessary to serve the homes and industry in a given area. No restrictions at all could lead to undesirable monopolistic practices.

The public service commissions set a limit on what a given power company can earn from its operations; generally this is about six per cent of the power company's capital investment in generating plants, substations, transmission lines, and distribution systems. This six per cent is not a guarantee, but an upper limit which the utility can earn for distribution to its stockholders. Thus, the power company operates under a slightly different set of economic rules than does an industrial manufacturer, who must be as good or better than his competitor in order to have any hope of making a profit.

Since a major part of the cost of

ATOMICS

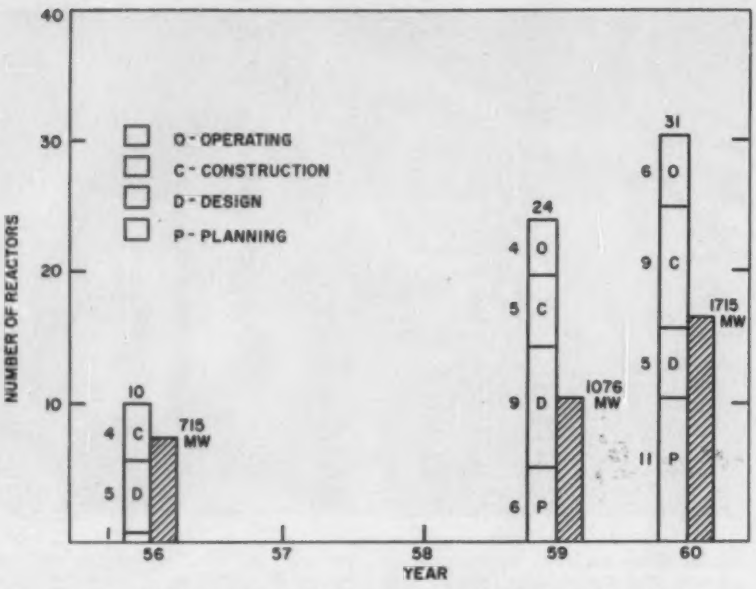

Fig. 1. Domestic Power Reactor Projects, 5000 kw and over

electricity to the consumer can be attributed to the cost of building and operating the power plants which generate the electricity, we should examine how a utility figures its generating facilities.

The cost of operating a large power plant — conventional or atomic — can be separated into three components: (1) the fixed charges, (2) the fuel charges, and (3) the operating and maintenance charges.

Now we can draw a comparison between a conventional gas, oil, or coal-burning power plant and an atomic power plant. Let's assume that a certain power company needs to add a large plant, rated 200,000 kilowatts, to its system. Should it add a conventional plant or a nuclear plant?

Our comparison starts with Table 1. The company can build a conventional plant for about $30,000,000, which amounts to $150 for every kilowatt of capacity. Let's assume it can build a nuclear plant today for about $42,000,000, or $210 for each kilowatt of capacity. The "fixed charges" will amount to about 14 per cent of these amounts every year, or $21.00 for the conventional plant and $29.40 for the nuclear plant per kilowatt of installed capacity, whether the plants run or not. If we assume that any plant the company builds will run at the equivalent of full load for 7000 hours each year, or 80 per cent of the time, then *each kilowatt* of plant capacity will turn out 7000 kilowatt hours of electrical energy during a year's time. The fixed charge portion of the cost of each kilowatt hour will be 3 mills for the conventional plant and 4.2 mills for the nuclear plant.

Let's assume now that this power company is located in Massachusetts, where coal and oil are expensive, compared to the rest of the United States. If this plant built the conventional plant, the fuel required for every kilowatt hour would cost about 3.6 mills. The fuel for the nuclear plant is uranium fabricated into the mechanical shapes, usually rods. When all the costs of the uranium and its fabrication are added up, the net fuel cost of the nuclear plant would be about 3.0 mills per kilowatt hour.

Operating and maintenance costs for both plants run about 1.0 mill per kilowatt hour.

Adding all the charges, Table 2 shows that we come up with a total of 7.6 mills per kilowatt hour for the conventional plant and 8.2 mills per kilowatt hour for the atomic plant. With this set of conditions, and our very much oversimplified analysis, the power company will obviously build the conventional plant. The numbers we have used are fairly representative of what can be done today, although most atomic plants now in operation or under construction are not as economical as this one. Why, then, are there over 30 nuclear plants in various stages of design, construction, and operation today, when conventional plants can turn out cheaper power?

Table 1. Fixed Charges for a 200,000-kw plant

CONVENTIONAL	NUCLEAR
$30,000,000 or $150/kw	$42,000,000 or $210/kw
14% of $150 = $21.00/kw year	14% of $210 = $29.40/kw year
(2100) / (7000) = 0.3 cents/kwh	(2940) / (7000) = 0.42 cents/kwh
3 mills/kwh	4.2 mills/kwh

Fixed charges are an annual fixed per cent of the total cost of the power plant. They cover such items as interest on the investment, taxes, the stockholders' return on the investment, and other things the utility must pay for, whether the plant runs or not. The next item of expense, the cost of fuel, depends on how much the plant operates. Operating and maintenance costs cover the salaries of personnel, supplies such as chemicals for water treatment, oil, paper towels, paint, and so on, and repairs to equipment.

The total of these, added together for a year's operation of the plant, and divided by the total number of kilowatt hours of electricity produced by the plant in that year, gives the energy cost per kilowatt hour, usually expressed in *mills* per kilowatt hour.

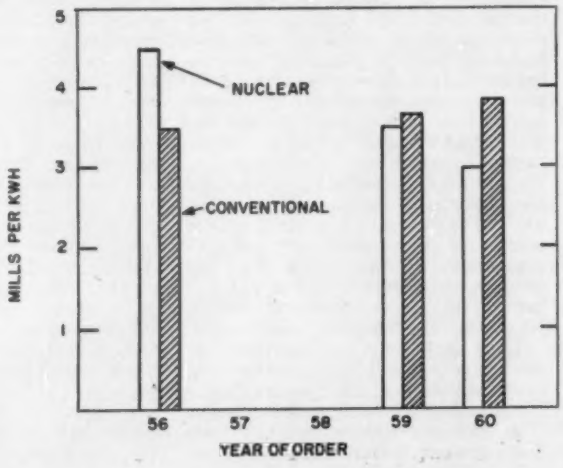

Fig. 2. Relative Capital Costs, Nuclear and Conventional Plants

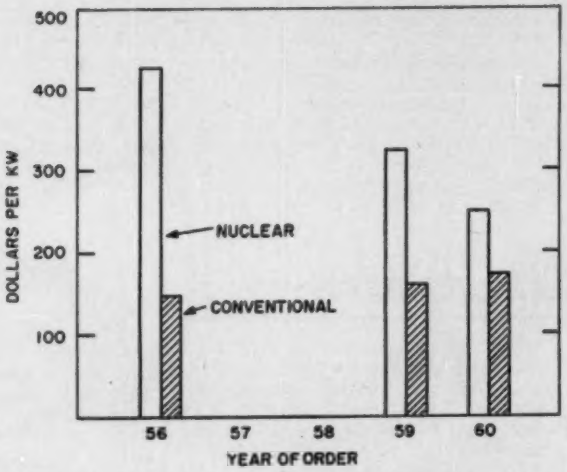

Fig. 3. Relative Fuel Costs, Nuclear and Conventional Plants

The answer lies in the fact that electric utility companies know that fossil fuel (coal, oil, gas) is getting harder to obtain, and that its cost is continually rising. Thus they must protect their long-term future. A transition to broad-scale nuclear generation cannot be accomplished overnight, however. Much research and development and actual construction of atomic plants are necessary before we know how to generate nuclear power more cheaply; but it is believed that nuclear power will be developed to an economic state for the above reasons and because it is needed now in some foreign countries. Our government and industry recognize this and are determined not to allow unfriendly nations to bring it to an economic state before we do, thereby gaining more recognition from nations friendly to us. Thus, atomic power will be developed in this country. Our nation's investor-owned electric utility companies recognize this, and have expended much time, money, and effort in research, development, and actual plant construction to contribute their share and to speed up the program.

Most of the nuclear plants which have been sold up to now are "developmental" plants. Their prime purpose is to demonstrate design principles, to test new ideas, to provide facilities in which to develop new concepts — in short, "to see how the scheme works." Power generated by them costs more than power generated in conventional coal, oil or gas-fired plants, except possibly in one isolated case, where unusual economic and logistic circumstances justify a nuclear plant.

Back in early 1956, there were only 10 nuclear power projects rated 5000 kilowatts and higher in the planning, design and construction stages, as indicated in Fig. 1. By 1959, the number was 24, of which four were operating. This year, there are a total of 31 — six operating, nine under construction, five in design and 11 in the planning stage. Total electrical power represented by these projects was 715,000 kilowatts in early 1956 and 1,715,000 kilowatts today — an increase of a million kilowatts. Utility companies, manufacturers and the government, recognizing that new sources of energy are essential to our long-term growth, have been and are willing to invest money, time and effort in these plants. It now begins to look like the investment will begin to pay dividends in this decade.

Table 2. Total Energy Costs for a 200,000-kw plant (Mills per Kwh)

	Conventional	Nuclear
Fixed Charges	3.0	4.2
Fuel Charges	3.6	3.0
O & M Charges	1.0	1.0
Total	7.6	8.2

Figure 2 gives the picture on capital cost improvement. Back in 1956, something more than $400 per kilowatt was considered to be a good average figure for the capital cost of a nuclear plant. Three years later $325 was about right. Today, just one year later we can build a large plant for slightly more than $200 per kilowatt. It took three years for the first $100 reduction, but only one year for the next $115 reduction. Such is the value of design and construction experience, combined with the intensive product development effort that we normally expect of a growing industry. During this period, some inflation has given rise to a slight increase in the capital cost of conventional plants.

Figure 3 shows what has happened to fuel costs. Back in 1956, 4.5 mills per kilowatt hour sounded like a pretty good number for the fuel cost of a nuclear plant. In 1959, 3.5 mills was about right, and today it looks like about 3.0 mills per kilowatt hour. These are numbers that a manufacturer would estimate for the fuel cost of a plant purchased in the year indicated on the chart and scheduled to operate three to four years later. During the period from 1956 to 1960, the fuel cost for new conventional plants in an area of high fossil fuel costs, such as New England, has risen slightly, due to inflation, so that, at the present time, the fuel cost of a nuclear plant is lower than that of a conventional plant in such an area. The nuclear plant has the added advantage of the promise of further reduction in fuel cost after it begins operating, since there is room for great improvement in fabrication techniques and materials. On the other hand, there is every indication that the fuel cost for a given conventional plant will continue to increase over the life of the plant. This factor is a potent one in evaluating the relative lifetime economics of a conventional plant and a nuclear plant which doesn't quite compete at the moment.

Nuclear power at about 13 mills per kilowatt hour in early 1956 was not competitive with any portion of the new steam generating capacity to be purchased in that year. By early 1959, the combined reductions in capital cost and fuel cost had reduced nuclear power cost to about 10 mills per kilowatt hour, and today with further reductions in capital costs and fuel costs attained during the past year, nuclear power at about 8 mills per kilowatt hour is on the threshold of competing for a portion of the power plant market even though slight gains in efficiency might be made for some time in future conventional plants.

This does not mean that the battle is won, however. We won't make nuclear power competitive in most areas of the United States without further intensive research and development, coupled with aggressive design and construction of advanced nuclear plants. This is recognized by both industry and the government.

Federal expenditures to date on nuclear power total approximately $657 million. A recently announced AEC reactor development plan involves the expenditure of about $1.6 billion over the next 10 years on research, development and prototype plants. The utility industry to date has committed some $500 million, mainly in plant construction. It is difficult to obtain accurate figures on the investment made by the nuclear manufacturing industry, but General Electric alone is expected to have close to $100 million committed to

ATOMICS

the business by 1970. A major portion of this is being expended in facilities and development work for the boiling-water reactor, which we believe offers the greatest promise for the next 10 years. The boiling-water reactor is the simplest nuclear reactor thus far developed.

The largest reactor ever built solely for electric power generation, a boiling-water reactor (which was built by General Electric for the Commonwealth Edison Company of Chicago), was installed late last year at the Dresden Station. Criticality tests were completed early this year, and the plant is now generating electric power for the Commonwealth Edison system, producing not only a substantial portion of the system's power requirements, but also providing a wealth of information to enable us to design better, cheaper, and more reliable nuclear reactors for incorporation in future power plants. Performance has exceeded expectations, and the day when nuclear power plants become "conventional," in every sense of the word, is not far off. THE END

New Nuclear Literature

* * * Today, a substantial proportion of the literature on nuclear technology is written in English. Although many scientists and technicians in other countries have a working knowledge of English, they may not know the meaning of many of the technical terms used in the current nuclear literature. In order to help in overcoming this difficulty the Philosophical Press has recently published a new *Dictionary of Atomic Terminology*. This dictionary sets out to provide a selection of the essential scientific and technical terms employed in connection with atomic and nuclear physics and associated fields, with the object of facilitating the study of the relevant foreign literature on the subject. Since a large proportion of the literature is written in English, the main body of this dictionary is based on English. The English terms are listed in their alphabetical order and numbered consecutively. Their German, French, and Italian equivalents are given in parallel columns with the same consecutive numbers. The main section is followed by alphabetically arranged German, French, and Italian indexes listing the terms with the numbers under which the corresponding terms in the other three languages will be found in the main section. For easier reference, each page of the main section carries in the top left- or right-hand corner the numbers of the first and last terms on that page; e.g. 145–168. Where a particular concept can be expressed by several terms in English, these are given in their alphabetical order; their equivalents in the other languages, however, are given against only one of these English terms, under which all the other synonymous terms are enumerated for reference; e.g.,

conversion factor
= conversion coefficient
breeding coefficient
breeding factor.

This dictionary was edited by Lore Lettenmeyer, and is published by The Philosophical Library, Inc, 15 East 40 Street, New York, N. Y. The price is $6.00. . . . Another new publication of the Philosophical Library is a 184-page book entitled *Nuclear Power Plant*. This little volume, by E. Openshaw Taylor, opens with a concise account of the world's energy requirements and resources, present and future. It then goes on to deal with nuclear and reactor physics, types of reactors, reactor engineering, instrumentation and control, and the economics of nuclear stations. The price of this book is $7.50. . . . . .

Samuel Glasstone is well known in the field of nuclear literature. He has written or collaborated in the writing of more than a score of technical books involving nuclear science and is perhaps best noted for his *Sourcebook of Atomic Energy*, which for many years has been the most useful reference book in the entire field. Those familiar with Sam Glasstone's work will, therefore, welcome his latest book which he wrote in collaboration with Ralph H. Lovberg of Los Alamos Scientific Laboratory. This is his *Controlled Thermonuclear Reactions*, published recently by D. Van Nostrand Company. Since the virtual complete declassification of information on controlled thermonuclear research was announced at the 1958 Geneva Atoms for Peace Conference at Geneva, Switzerland, this field of research has fired the interest and imagination of the entire world, not only because of its far-reaching political and economic aspects but perhaps even more because of the exceptionally challenging nature of the scientific and technical problems involved. Thermonuclear fusion reactions are known to be the energy source in two widely different situations. At one extreme, relatively slow reactions of this type produce the energy of the sun and stars, whereas at the other extreme, rapid thermonuclear reactions are responsible for the explosive power of the hydrogen bomb. Somewhere between these two extremes, it should be possible to bring about thermonuclear reactions under conditions which will permit energy to be released at a controllable rate. Controlled thermonuclear reactions, in which there is a net gain of energy, are possible in principle, and so could serve as a source of useful power.

Since the general declassification of thermonuclear data, a great deal of information on controlled thermonuclear reactions has appeared in literature, in the form of scientific as well as popular articles and papers, and a number of books have been published on the subject. Some of this published literature has been of a highly specialized nature suitable only for those actively engaged in this type of research, whereas other material has been of a semi-popular nature intended for the intelligent layman. This new 523-page book by Glasstone and Lovberg takes a somewhat middle course. Its main purpose is to provide the necessary background for physicists and engineers who are planning to enter the field of research into controlled thermonuclear reactions. The treatment is directed largely to experimentalists, but sufficient theory is introduced to enable the reader to appreciate the principles underlying the observed phenomena. The theoretical derivations given are often simplified, since they are intended to provide a physical picture rather than to reresent a rigorous mathematical approach. *Controlled Thermonuclear Reactions* is essentially a survey of the basic principles and of the experimental approaches which are being followed in the effort to develop procedures which might be used to produce controlled energy by nuclear fusion. After considering the physical conditions necessary for the possible methods of achieving fusion, the authors discuss the properties of plasmas of thermonuclear interest, the methods of producing such plasmas, and the techniques for studying their properties. The authors describe the work done on the pinch effect, the Stellarator, magnetic mirror systems, the Astron concept, and other proposed methods for plasma heating and confinement. The book concludes with a review of the sources of energy loss from heated plasmas and an outline of the plasma stability theory. In addition, numerous references provide a reasonably complete coverage of the now extensive literature of controlled thermonuclear reactions and allied topics. For the practicing engineer and scientist and for advanced students in physics and engineering, this up-to-date introduction to a challenging new field of research will be invaluable. *Controlled Thermonuclear Reactions*, by Samuel Glasstone and Ralph H. Lovberg, is published by D. Van Nostrand Co, Inc, 120 Alexander St, Princeton, New Jersey. The price, $5.50. * * *

THOMAS A.

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A Nalco PRODUCT MANAGER

Answers Questions about Cooling Tower Deterioration And Other Microbiological Problems

More Knowledge, Better Chemical Controls Offer New Paths to Economical Tower Treatment

Since cooling towers offer many types of fungi and bacteria choice conditions for growth, the battle for microbiological control is a continuing one throughout the country.

Nalco approaches cooling tower protection as part of the overall job of keeping the entire cooling system free of scale, corrosion, and microbiological growths of all kinds. Such a complete program is essential for most efficient cooling tower and system operation.

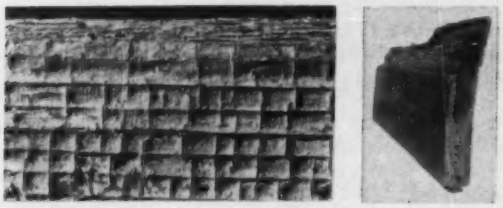
Here are some of the frequently-asked questions about cooling tower deterioration; and the answers we believe to be accurate.

Question: How can you tell when wood is being attacked chemically or microbiologically?

Answer. Careful tower inspection, plus microbiological analyses of wood from various parts of the tower (framing, fill, mist eliminator, top deck, and stack), and from samples of cooling water.

Question: Is wood deterioration common to certain parts of towers?

Answer. No. Microbiological attacks may occur in any part of the tower. Internal decay or deep rot is common to non-water-washed sections; while surface decay or chemical attack may occur anywhere in the system.



Wood deterioration samples from cooling towers. Left, cross checked surface decay; right, deep internal rot.

Question: Does tower location make any difference?

Answer: Apparently not. Towers throughout the world have been attacked.

Question: What types of organisms produce wood decay?

Answer: The same ones that produce forest decay. Organisms of the Fungi Imperfecti class cause both surface decay and internal rot. Deep rot is also caused by fungus organisms of the Basiodiomycetes class. Both classes are cellulolytic organisms—cellulose eaters, in effect, as they convert cellulose for nutrient uses, and in so doing, weaken the wood to the point of eventual collapse.

Question: Does chlorine predispose wood to microbiological decay?

Answer: There are considerable data, gathered by interested independent organizations, indicating that deterioration is prevalent in towers using chlorine as an algicide and bactericide. Whether chlorine predisposes wood to decay has not been fully established. However, actual plant experience indicates that a non-oxidizing microbiological program can provide control of wood deterioration. Nalco non-oxidizing microbiocides can also be used to provide protection against decay where chlorine is a part of the overall control program.

E. H. Hurst, Product Manager, Water Stabilization Chemicals, Nalco Chemical Company

Question: Do any chemicals do a complete job of microbiological control in cooling towers?

Answer: Yes. A Nalco program of non-oxidizing microbiocides designed and engineered for your plant problems can provide complete control against all types of microbiological activity . . . slime, algae, corrosive bacteria and wood decaying organisms.

Question: Do these non-oxidizing microbiocides *stay* effective? Economically?

Answer: Yes, although changes or additions in the types of organisms present may change the type or dosage of treatment used. Nalco programs have the flexibility required to meet such changes and maintain effective control. Long-range economy of a Nalco program for complete cooling system protection is being demonstrated in hundreds of systems—some of them for twenty years or more!

Question: Is this the whole story on microbiological control and deterioration?

Answer: It is hardly a beginning! Details on Nalco chemicals and services, and specific programs for cooling system protection are available promptly from your Nalco Representative. Ask him about the searching, comprehensive surveys and analyses made before a program is recommended . . . About the continuing surveillance of program effectiveness and economy . . . And let him show you, specifically, what Nalco can do for you.

On request: A technical data file containing more than 24 pages of information on this subject. Ask for File C3, Microbiological Control.

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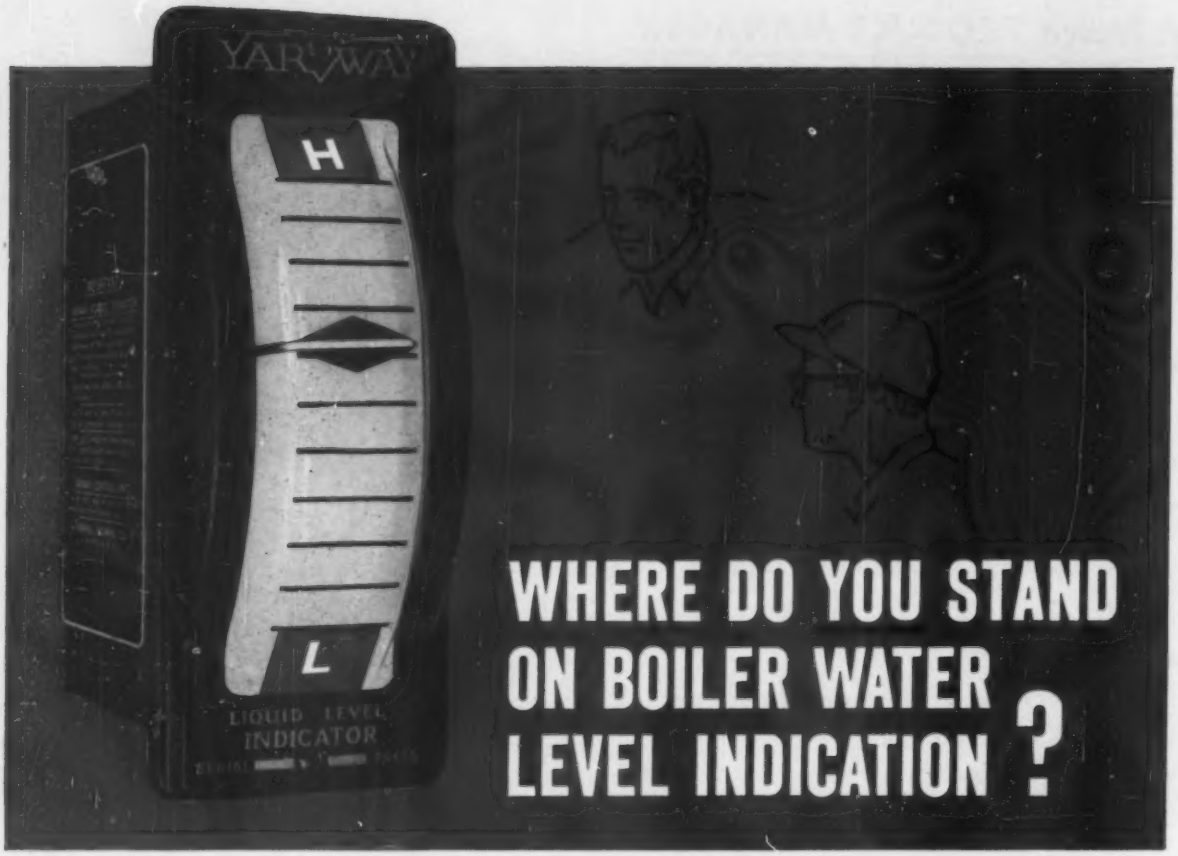

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Yarway Remote Liquid Level Indicators conform to this ruling and are used widely for primary boiler water level indication in plants operating at 900 psi and above.

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If you would like a reprint of this Boiler Code ruling, just ask for Case #1155 reprint.

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COMING IN JANUARY

The entire Power Industry is vitally concerned with new sources of power, despite the fact that we have many years' supply of fossil fuels. Power economists are predicting a shortage within the foreseeable future; this might be fifty years or 150, but new sources must be developed in plenty of time.

Much has been written on some of the "exotic sources" of energy, and a round-up of this information will be of interest to all of our readers. Some of the top experts in the field of unusual power sources will be giving you their ideas in a special section in the January issue of POWER ENGINEERING. Andy Kramer, our own Atomics expert, will contribute his thinking to this special issue.

Included in this timely collection of articles will be discussions of MHD, Thermoelectric, Thermionic, Photovoltaic and Fission fragment collection power sources.

Also, Fuel Cell Energy, and Conversion of D-C to A-C will complete the round-up of exotic power sources — as they exist today. This Special Section should be of great interest to all power engineers.

Bob McCaw
EDITOR

Power Engineering

MORE ON TAUM SAUK HYDRO

SPECIAL REPORT CONTINUED ON MISSOURI PUMPED-STORAGE PROJECT

About the Author

G. P. Gamble graduated as an E.E. in 1922 from the Univ. of Virginia. After two years with General Elec. Co, he spent 8 years with Stone and Webster in several important engineering positions.

In 1950 he was made Vice-President; in 1954, Operating V. P.; and in 1960, an Executive V. P. of Union Electric Co.

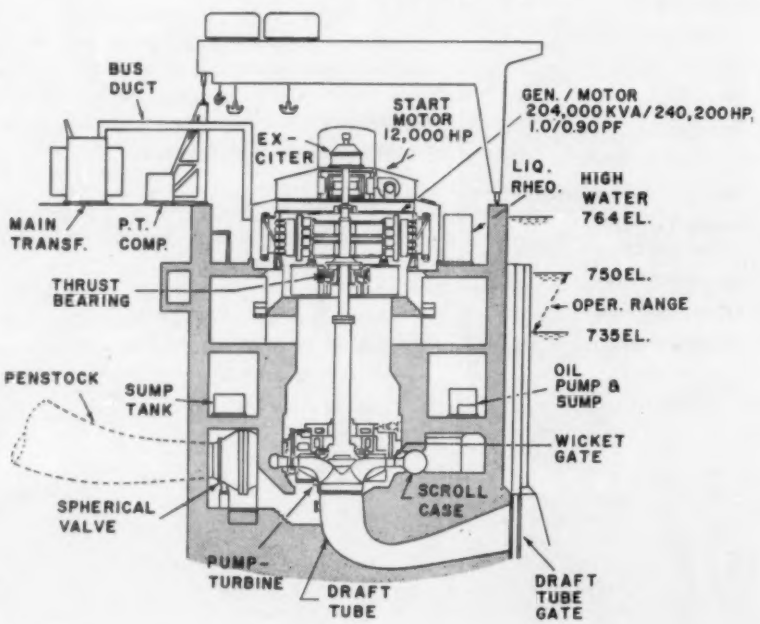
In 1935 the author developed the basic principles of the application of Shunt Capacitors on Distribution Circuits, for the purpose of increasing the load carrying ability of such circuits through voltage gradient improvement. His company made the first such applications, and great economies in electrical distribution have resulted.

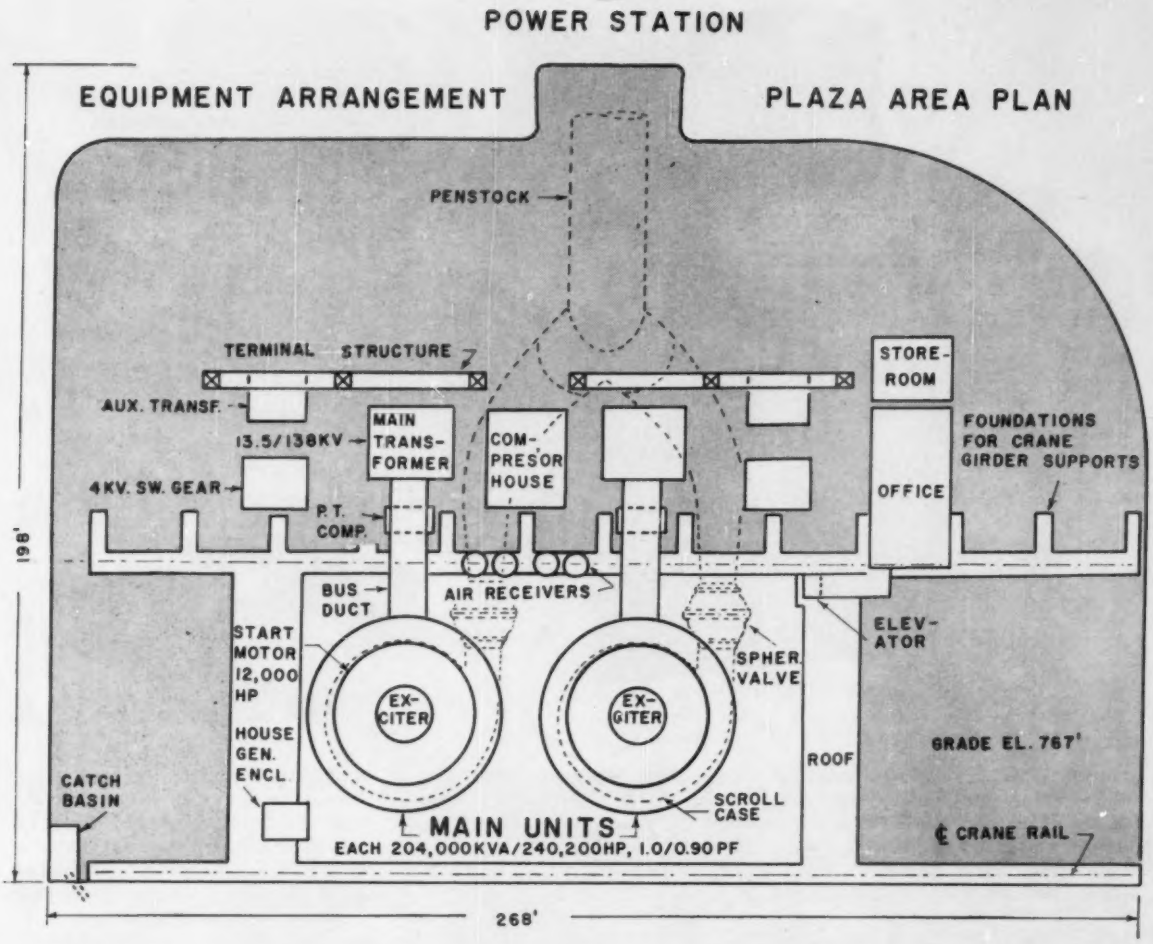
PLANNING and development of the Taum Sauk Plant site was described in the first article which appeared in Nov 1960, page 56. The principle of pumped storage and the study of pumped storage by Union Electric Co were explained. Results of the study, selection of the plant site, and preliminary engineering work were also described.

A contract for construction of the powerhouse at the Taum Sauk Plant, and the hydraulic portions of the project, was awarded to Fruin-Colnon Contracting Co, of St. Louis, and the Utah Construction and Mining Co, of San Francisco, as joint-venturers.

Through the 6 years of study, the Allis-Chalmers Manufacturing Co, developers of the reversible pump-

POWER STATION
EQUIPMENT ARRANGEMENT
SECTION AT A MAIN UNIT





turbine runner (and a leading manufacturer of large hydraulic equipment), rendered great assistance by supplying dimensional data, performance curves and estimated equipment costs — for units of many different sizes, and heads — to fit the wide variety of conditions investigated.

Two pump-turbine units, with their associated hydraulic gear (including two 108-in. spherical valves weighing 350,000 lb each), have been purchased from Allis-Chalmers. Also, two electric generators, complete with starting motors and direct-connected exciters, have been purchased from General Electric Co. Construction work on the project has been started, and the plant is scheduled to go into commercial operation in June of 1963.

In February of 1960, the company applied for, and received from the Missouri Public Service Commission, a Certificate of Convenience and Necessity to construct the plant. Also in February, it filed a Declaration of Intention with the Federal Power Commission in Washington. It is the Company's belief that the project is not subject to Federal license. However, since no ruling as to jurisdiction had been made by the Commission, in June 1960, at the suggestion of the Commission's staff, the company filed an application for license — so the preliminary procedural steps leading to a license might be taken while the jurisdictional question was being resolved.

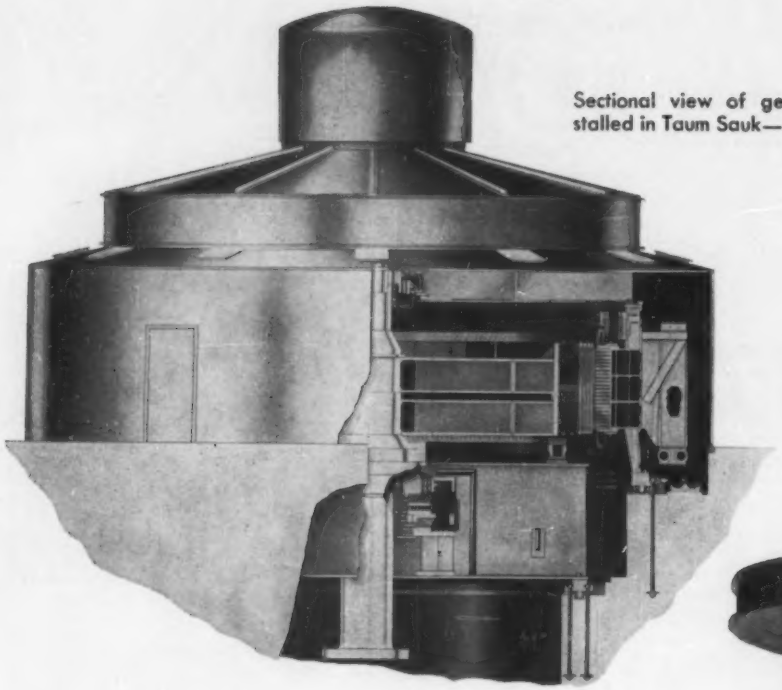
Taum Sauk has been cleared, as properly accreditable capacity, by the Illinois Power Co and the Central Illinois Public Service Co, associates of our company in a power interchange pool.

Major economic penalty against pumped storage springs from the fact that many low-cost kwhs would not be available to the system because the capacity provided by such a plant displaces capacity which would otherwise have been installed as new steam-driven equipment, capable of operation at high load-factor. Some two billion six hundred million low-incremental cost kwhs would have been available from an equivalent-size steam unit. This represents a penalty of over two million dollars in the first year. Fortunately, this penalty decreases rapidly over the years as additional low-operating-cost generation becomes available.

Cost of the actual power loss, in the pumping-generating cycle of such a plant, is a comparatively small factor in the economic equation since the plant would be operated relatively few hours per year. Load-factors decreasing from 5 to 2 per cent over the years are anticipated, with eventually an almost pure reserve status possible.

Thus, it is evident that these losses are not only small, but diminish with the years as the hours of use of the plant decrease. Their cost would be still further reduced as the value of marginal energy used for pumping decreases. This latter effect operates as a self-modernizing feature.

A transmission penalty against pumped storage could normally be expected. This is true, not only because the distance from the load-center to a favorable site would usually be more than for a steam plant, but also because energy used for



Sectional view of generator-motor units to be installed in Taum Sauk—being built by General Elec. Co

Gigantic reversible pump-turbine, designed and being built by Allis-Chalmers Mfg Co, illustrated below

pumping comes from system facilities which are not the same ones suitable for absorbing power generated from pumped storage. There is such a penalty at Taum Sauk, but it is a tolerable one, the more so because a large part of its transmission would be required within a few years for system development.

Manning-cost credit to Taum Sauk will be substantial initially, and will increase over the years, depending on the rate of wage escalation. After about the 10th year, it will outweigh the energy penalty and will exceed this penalty by a wide and ever-increasing margin as the years go on.

Foundation for the economic justification for a pumped-storage plant still lies, however, in the carrying-charges applicable to construction costs, as compared to the carrying-charges on equivalent steam capacity. Each company, or system, must determine its own balance point. Taum Sauk will be built for about $115 per kilowatt, without transmission, based on its 350-Mw day-end rating.

A few sites are available in the system area at which, it is believed, economical pumped-storage projects can be constructed up to a total of possibly 1500 Mw. It is probable that some, or all, of these may be developed by the 1980's. The author believes, however, that the justification for pumped-storage installations will become more difficult as the size of steam units increases, there being a physical limit to the size of hydraulic units not yet apparent in the steam turbine field.

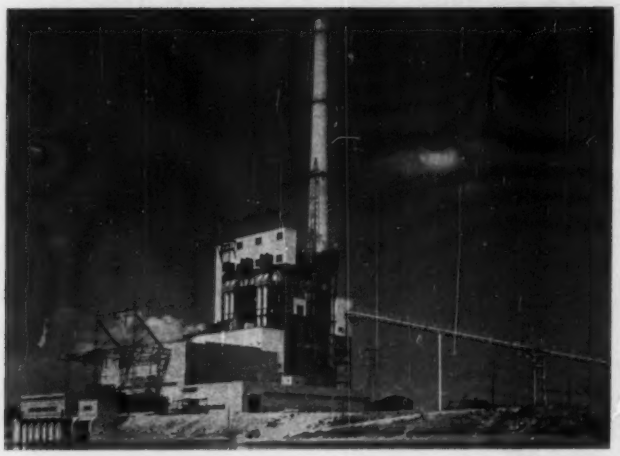
Number of kilowatts which can be put into one unit is still a factor in construction and operation cost, and will continue to be. Justification for pumped storage will also become more difficult, to the extent that further centralization and automation of steam plants can reduce manpower. *Taum Sauk is being designed as a completely automated plant, requiring no operators.*

There will be a number of technical papers written from time to time on Taum Sauk and its various aspects. Suffice it to say here that there will be two units, each with a 225 to 175 Mw rating, from maximum to minimum head. The head will vary from 858 to 745 ft. The units are of the Francis type, capable of operating efficiently either as pumps or turbines, simply by reversal of rotation. These will be the most powerful hydroelectric units built to date, although not the largest in physical dimensions. This is due to the 200-rpm speed and the 800-ft head used. The thrust bearing of each unit will carry something over 2,000,000 lb. The shaft between the water-wheel and generator will be just over 48 inches in diameter.

There will be a 25-ft-diameter tunnel through the granite mountain for a distance of some 6000 ft, and a 600 ft shaft will rise from the end of this tunnel up into the bottom of the reservoir. The lower end of the tunnel will be lined with an 18-ft-diameter pipe of T-1 steel, connected through a "Y" to supply the two units, each through a 108-in. spherical valve.

There will be no headworks, as would be found in a conventional hydroelectric plant. The tail-race will consist of an excavation, 1500 ft long and 65 ft wide, between the powerhouse and the lower reservoir. About five million tons of water will be handled in each direction in the cycle of a full-use day, a weight equivalent to that of 100 battleships.

Installation of the Taum Sauk plant on the Union Electric System will result in very substantial savings year-by-year, as against the installation at this time of a steam unit. The operating dependability and flexibility, when coupled with the virtual instantaneous availability of a block of power of over 400 Mw when floating as reserve, combine to make a very useful tool in the future operation of the system. This is true even though Union Electric's Osage hydroelectric plant has a peaking ability of about 200 Mw, and the system has retained its older steam plants as low load-factor capacity. Systems with a lesser proportion of plants best suited for peaking purposes could easily find a pumped-storage installation even more attractive, should a suitable site be available. THE END



BREED ELECTRIC GENERATING PLANT DEDICATED

IMPRESSIVE CEREMONY CHRISTENS ONE OF COUNTRY'S MOST IMPORTANT ELECTRIC PLANTS—PART OF INDIANA AND MICHIGAN SYSTEM

Pictured with Editor Bob McCaw (r) at dedication of Breed are (l to r) R. E. Doyle, vice-president, Indiana & Michigan Electric Co; Homer Sager, manager, Breed Plant; Philip Sporn, president of the AEP Company

FORMAL DEDICATION of the Breed electric generating plant was held on October 6th. This station is one of the most modern in the country and has one of the largest single generating units ever built. Breed station is owned by Indiana and Michigan Electric Co, which is part of the American Electric Power System.

Dedication ceremony was presided over by Dr. Philip Sporn, president of American Electric Company. Some of the honored guests included Governor Handley (Ind.), Senator Hartke (Ind.), Mr. and Mrs. Richard Breed, Morris Nielsen, president of Babcock and Wilcox, and Howard Wright, chairman of Republic Coal and Coke Company.

This plant has one complete unit, consisting of a 475,000-kw turbine generating unit; its ultimate capability will be over 500 Mw. It was built by General Electric Company.

Steam is supplied by a Babcock & Wilcox steam generator, furnishing about 3 million pounds per hour. Steam pressure at the turbine is 3500 psi, with steam temperature of 1050 F.

As an integral part of the project, the Thunderbird coal mine was developed exclusively to supply this plant with fuel; this mine is part of the Ayrshire Collieries. Ten miles of railroad connect the mine with the plant.

To get the energy generated by this plant into the AEP System, some 186 miles of double-circuit, 345-kv transmission line had to be constructed. This runs from the Breed plant to a point on the AEP System — ten miles west of South Bend, Indiana.

Cost of the plant was over $70 million. Then, more than $10 million was spent for the development of the mine and railroad; also $22 million for the transmission system. This brings the cost of the complete power complex to over $100 million.

The plant will consume 1.4 million tons of coal a year and is expected to have a heat rate of 8530 Btu per kwh. This results in a thermal efficiency of better than 40 per cent.

Significant is the fact that, by the addition of this unit to its system, I. and M. has increased its generating capability by 50 per cent, and to over 1,400,000 kw total. Further, it will increase the total AEP System power total to over 6 million kw.

Breed plant is certainly a great tribute to all of the engineering and operating personnel, of both I. and M. and American Electric Power Co, who had a part in its design, construction and start-up. THE END

Power Engineering

DEALING WITH STEAM SIDE EROSION OF CONDENSER TUBES

IT'S BASICALLY A MATTER OF STEAM VELOCITY AND MOISTURE CONTENT, AS R. A. WILSON, ALLIS-CHALMERS CONSULTING ENGINEER, EXPLAINS IN THIS CONTINUING SERIES ON THE MODERN CONDENSER

TREND in the design of power plants is toward increasingly compact units. While this is understandable, it tends to accentuate the problem of steam side erosion of the condenser. If this problem is understood, steps may be taken to provide an arrangement which will achieve both a compact unit and minimum erosion. Existing erosion effects may also be reduced after the unit is in operation, by other measures.

In a number of cases, condenser tubes have been eroded by the high velocity wet steam from the turbine. From an over-all viewpoint, it appears that the load on the unit has a bearing on how serious the erosion will be. One unit started operation in the early '30's and had no serious erosion trouble during several years of operating with very little heavy load duty, but experienced considerable erosion trouble after 15 years of service when put on extremely heavy loads for sustained periods.

This problem can be approached from a consideration of turbine exhaust sizes and arrangements and condenser placement. Basically, erosion of the condenser tubes and also the structural parts of the condenser is a function of steam velocity and moisture content of the steam, and, of course, the hardness of the part under attack. The average steam velocity leaving the turbine exhaust and the average moisture content may be of considerable importance, but the local velocity and the local moisture content are of greater importance.

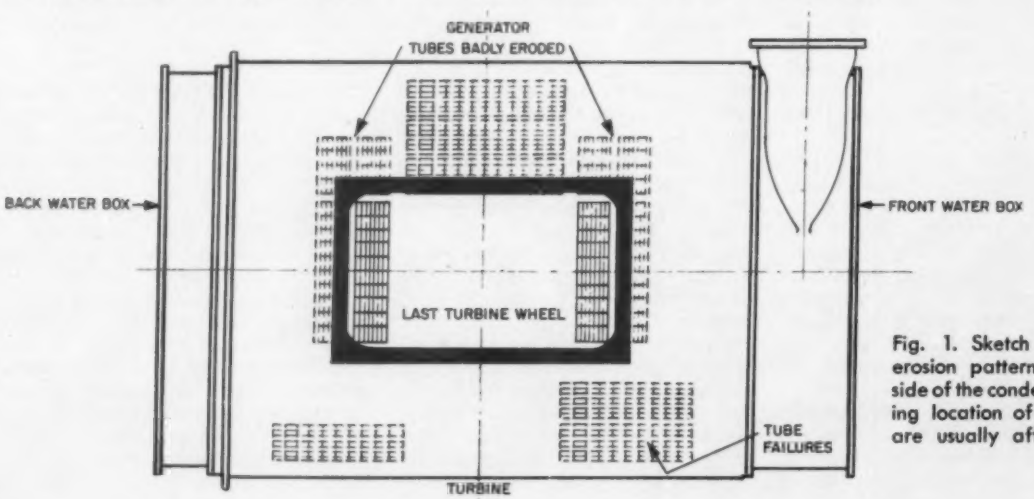
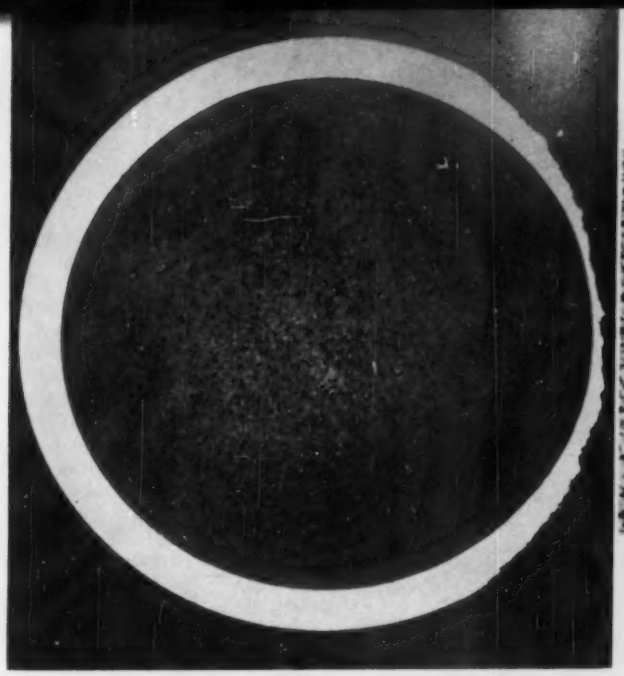


Fig. 1. Sketch of typical erosion pattern on steam side of the condenser, showing location of tubes that are usually affected first



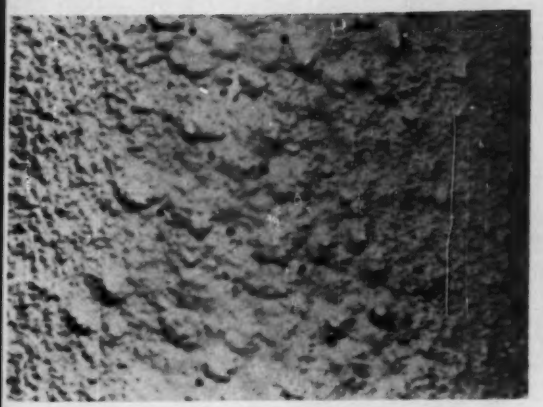


Fig. 2. Close-up of copper alloy tube showing failure by erosion after several years of service

Fig. 3. Copper alloy condenser tube showing erosion from effect of high velocity water particles

Turbine builders have conducted tests, some of which have been published, and others are fairly well known, indicating that at full load and about 1.5 inches or lower absolute pressure the maximum velocity at the turbine exhaust flange will be expected to be 2.5 to 3.0 times the average velocity. This is alarming, considering how high the average exhaust velocity may be on many modern turbines.

Pressure level is very important since the velocity varies inversely with the absolute pressure. Average velocity is twice as high at 0.75 inch absolute pressure as at 1.5 inches absolute pressure. Thus it can be seen that cold circulating water results in low absolute pressure and therefore adds to the problem.

Variation in moisture content of the steam is probably even more than for the velocity, but it is more difficult to measure, and information on such measurements is not readily available.

It is very desirable to flare out the condenser inlet nozzle as much as possible between the turbine exhaust flange and the top rows of tubes. High velocity steam cannot be expected to turn and fill the flow area efficiently where the expansion is very abrupt. In any case, the variations in velocities near the top row of tubes will be greater with extremely short distances between the turbine exhaust and the top row of tubes than with a more conservative distance which will allow some redistribution of velocity.

It should be apparent that the size and shape of the turbine exhaust, the size and shape of the condenser tube bank, as well as the distance between them and whether they are parallel or perpendicular to each other, will all have a bearing on the amount and distribution of possible erosion. In some cases it seems that the moisture becomes attached and runs down the walls of the condenser instead of hitting the tubes at high velocity.

New Developments

In addition to the present problems there are new developments in steam turbines. First, they are rapidly getting larger. Blades are getting longer and the area of the annulus has increased greatly. This adds to the problems of velocity distribution. A large jet will carry further and is more difficult to slow down and diffuse than the same steam flow in many small jets. The range of a large fire hose compared to small hoses illustrates this point. The same factors have been responsible for breaking the discharge from jet engines on airplanes into many small jets instead of one large one, in order to reduce noise and other problems connected with high temperature, high velocity jets at airports.

In some cases diffusers are now being used which extend one-half to two-thirds of a blade length beyond the blades. This is to increase the jetting velocity of the steam and to get more work from the blades in the last row. At this time the effect on turbine performance is not fully known, and the effect on condenser problems and design is not fully known or appreciated. It is quite evident that moisture will not be separated from the steam at the end of the blades but will continue down the diffuser. This higher velocity, larger diameter jet will have less room to turn toward the condenser due to the long diffuser.

It is quite certain that if these new developments add to steam turbine and plant efficiency, the condenser designers, consulting engineers and the utilities themselves, who are the deciding force, must learn to provide the necessary space and designs to allow for solution of the new problems that may also develop.

Several of the factors pertaining to the configuration asscciated with the flow transition have already been mentioned. These are the amount of flare of the condenser inlet, the distance between the turbine inlet and the top row of tubes, the size and shape of the exhaust and of the tube bank, the relative arrangement of the tube bank and the turbine, and the configuration of any diffuser used. In addition to these factors the placement of other items may also affect the flow configuration.

Most turbines require that extraction lines be brought out through the condenser neck. Also, many engineers place extraction heaters in the neck. This may in some cases do little harm but it generally interferes with flow, adds pressure loss, and may make a very bad flow pattern.

Another pertinent item is the great number of drains and drips going into the condenser. The condenser is of necessity a sump for the system since the turbine and all the high-pressure piping have drains and vents that must go somewhere. These can have a marked effect on the flow configuration. Much better placement of this piping with regard to obtaining deaeration and minimizing erosion on tubes and shell parts can be made

Fig. 4. Effective way to prevent tube erosion is by stainless steel clips

if it is known what the maximum flow rate will be, what the maximum temperature will be, and the pressure of steam lines being drained.

As far as erosion on the shell parts is concerned, in some cases it can only be minimized because there will be some erosion no matter what is attempted. To reduce erosion, however, baffles can be placed over connections in the condenser shell. Usually the difficulty in this situation arises from the fact that the desired information is difficult to obtain.

The way then to minimize erosion more nearly is by arrangement of the flow configuration after consideration of all the factors involved. To accomplish this, adequate space must be provided.

Other Preventives

In general, however, it is difficult to determine the location and seriousness of any erosion which may develop, until after the unit goes into service. At this time other preventive measures may be considered in minimizing any erosion found to be occurring. Attempts have been made to solve the problem of higher steam velocities due to cold winter water by using floor grating, which must be installed very close to the tubes in order to be effective. In a few cases this has been very satisfactory. Floor grating installed three or four feet above the tubes may be harmful rather than helpful, but when it is installed within six inches of the tubes and in such a way that it will catch and stop, or at least slow down the water particles, it has been quite successful.

One of the most effective and at present one of the most common methods of preventing steam side tube erosion is the use of stainless steel clips. These clips can be easily clamped over a tube in the area of erosion damage. Stainless steel has a much greater erosion resistance than the normal condenser tube alloys.

Some units going into service will have stainless steel tubes on the outside of the banks, where experience has indicated that erosion is most likely to occur. There is a definite trend in the use of stainless steel tubes for protecting the tube bank from erosion, and such use is expected to increase. The idea is good if the circulating water is suitable for stainless steel tubes, and it is not necessary to acid clean the condenser.

Acid cleaning of stainless steel tubes with hydrochloric acid may harm them. In some plants duplex tubes have been used, with stainless steel on the outside and brass on the inside. Arguments for this arrangement are that should the unit be acid cleaned on the water side, there would then be copper alloy tubes only in contact with the acid; or that the circulating water may be harmful to stainless tubes.

In some cases high velocity flow induces vibration in the tubes in a tube bank. Tube vibration is seldom, if ever, caused by machine vibration. The high velocity flow may induce vibration at the natural tube frequency. Tube vibration damage can be from stress in the tubes, wear at support plates or wear between tubes, or by a combination of these effects. Damaging vibration may be caused by extreme high steam velocity, long tube spans, extremely flexible tubing, close tube spacing, or a combination of all of these effects. High flow velocities may be caused by uneven velocity distribution from the turbine or from a local high velocity due to high velocity jets from small pipes coming to the condenser.

Using Baffles

It is common practice to place baffles over all connections on the condenser shell, such as drips, drains and vents. At first glance this would seem to protect the tubes. Actually if the flow is too great and there is a mixture of steam and water, there may be an erosive jet coming off the baffle that may still damage tubes. A line carrying superheated steam may be discharging against a baffle, and the velocity coming off the baffle may be great enough to cause tube vibration in a local area.

It is necessary to have a good estimate of the maximum flow that enters a baffled area and then evaluate the velocity, pressure and direction of flow from the baffled area, to check the design of these baffles. Flow may be high enough to give sonic velocity and a discharge pressure higher than condenser pressure. Baffles to slow down and distribute steam require shell space and some freedom for good location by the condenser designer.

Floor grating has been used to reduce the damaging velocity to a vulnerable tube area by causing a pressure drop through the grating. This may be effective depending upon circumstances; however, it may change the flow distribution and increase the velocity elsewhere.

Tube bundles have been laced with flattened condenser tubes. Metal bars have been used, but flattened tubing is preferred. This lacing can give support and additional stiffness to the individual tubes and the tube bank and very effectively prevent damaging vibration.

Same flow conditions that promote erosion may promote vibration. Moisture distribution in the flow is important in tube erosion. It is only the flow distribution that is important in inducing vibration.

In a subsequent article, we will discuss the problems connected with steam side corrosion. THE END

WANT MORE BOILER CAPACITY? HERE'S AN EASY WAY TO GET IT

CONSULTING ENGINEER WILLIAM T. BROOKMAN DESCRIBES FIELD TEST ON BOILER EXTENSION

EVENTUALLY, most every consulting engineer is confronted with the problem of designing for plant expansion, with insufficient boiler capacity available, and often with insufficient floor space to add a new boiler to handle the additional load. Many times the solution to this problem determines whether the client will or will not expand.

Being aware of the importance of this problem, we became interested in the adaptation of Waterwall furnace extensions to the existing boiler. Naturally, we had our doubts and reservations, but realizing the possibilities it offered, our office made a critical and impartial study of the performance of this equipment.

We called the local supplier for an engineering analysis of the design of the Waterwall. After a thorough study, we were of the opinion that the engineering of the equipment was sound, so we proceeded to check on some of the local installations.

After examining the installations at one commercial and one industrial facility, we were convinced that the Waterwall did increase the capacity and combustion efficiency.

At this time, we were designing an addition to a high school. We were faced with the requirement of additional boiler capacity, and there was insufficient room for installation. We decided to specify a Waterwall furnace extension. The results were surprising; for not only did we handle the increased load, but there was a substantial fuel savings.

As a result of the savings that were shown on the high school project, we decided that a further investigation was warranted. We contacted the supplier and received a list of installations that he had made, in which there were two boilers, one with a Waterwall and one without. From the various installations submitted, we decided to run a field test at one: Coca-Cola Bottling Co of Chicago, Inc. We then made arrangements to perform efficiency tests on their two boilers.

In order to make tests of value, it was necessary to determine the evaporation rate. We connected two hot water meters — one on the discharge line from each boiler to the condensate pump; two cold water meters (on the water feed line from the water feeders to each boiler); two oil meters, on the fuel lines to the oil burners of each boiler.

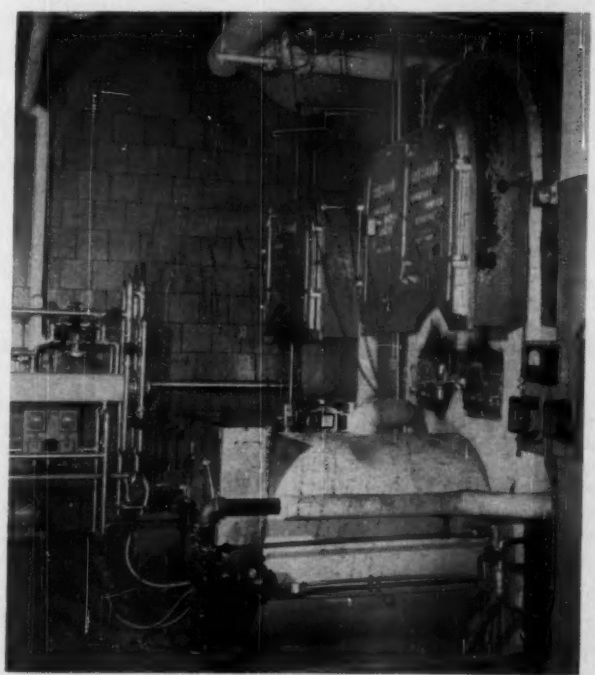
Oil meter recorded the amount of oil used by each burner; the water meter recorded the amount of water; the condensate meter showed the amount of water evaporated and returned to the boilers. The water feeder meters showed the amount of water lost through processing.

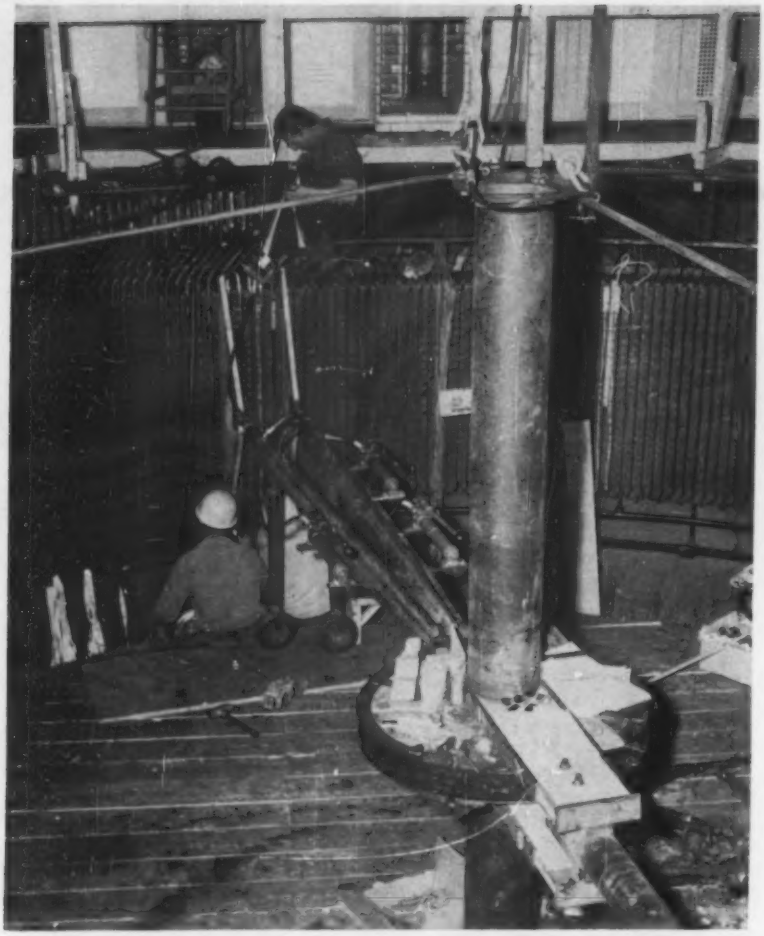
Equipment necessary to calibrate the meter included a scale, a 55-gal drum, a five-gal drum and a pyrometer. The drums were weighed for accuracy. Also, to obtain an accurate measurement, we weighed the oil at 120 F to determine the number of pounds of fuel it contained.

After checking the Btu content of the fuel, its temperature and weight, we were in a position to determine the number of Btu's the five-gal drums contained. Drawing off 50 gallons of water into the 55-gal drum, and knowing the temperature of the water, we were able to calibrate the meters to determine their accuracy. With the oil and water meters calibrated, we were ready to proceed with the test.

The supply and water meters were placed ahead of the water feeder, and the meters were installed on the outside of the condensate return system. As the pumps returned the water to the boiler, these calibrated meters recorded the weight of water being brought back to the boiler.

A summary of the test data showed that the boiler having the Waterwall installation evaporated an average of 15.5 gal of water per gallon of oil. The boiler without the Waterwall evaporated an average of 11.1 gal of water per gallon of oil. The fuel used was No. 5 oil — having a Btu value of 149,000. Converting this data to relative boiler efficiency, we find the efficiency of the Waterwall-equipped boiler to be 84 per cent, while the efficiency of the other boiler was 61.6 per cent. THE END





Coil-pushing machine is shown installed for rewinding a 40,000-kva generator. Arms and counterweight are attached to a plate which rotates on a stub shaft installed on the coupling face of the turbine runner shaft. The arms, made from angle iron, are set to match the pitch or "throw" of the winding. Aluminum pusher plates are interchangeable to permit rewinding different size generators. Three hand-operated hydraulic jacks are used in operating the machine.

HYDRAULIC TOOLS AND SIMPLE JIGS SIMPLIFY GENERATOR REWINDING

Two jacks supply pressure to the rams which force the coils into the slots, while the other jack is employed with special rigs to force the loop of the coils into position and back against the tie-ring. This assures uniformity in the shape of the coil-ends throughout the winding. Coils are pushed into the generator slots evenly and firmly, eliminating damage to insulation which frequently occurs when employing fibre blocks and a sledge hammer. This tool is a money saver, and greatly facilitates a generator rewinding operation.

AIEE HOLDS FALL GENERAL MEETING

NEW SOURCES OF POWER, POWER PLANT AUTOMATION AND MASS WARNING SYSTEM AMONG MANY INTERESTING DISCUSSIONS

Fig. 1 (left to right). Messrs. Linder, Borden, Concordia, Weber, and Kompfner

ELECTRICAL ENGINEERS GATHERED IN CHICAGO during the week of Oct 9–14, for their fall General Meeting. At the first session, presided over by C. H. Linder, president of AIEE, five men were honored for their contributions to the field of electrical engineering, Fig. 1.

Dr. Ernst Weber, president of Polytechnic Institute of Brooklyn, was awarded the AIEE's Medal in Electrical Engineering Education; Prof. Perry Borden, Electrical Engineering Department, University of Dayton, received the Morris E. Leeds Award; Dr. Selden B. Crary, system analysis engineer, Electric Utility Engineering Section, General Electric Company, was given the William M. Habirshaw Award (accepted for him by Charles Concordia); and Rudolf Kompfner, director of radio and electronics research, Bell Telephone Laboratories, Inc, was presented with the David Sarnoff Award.

The fifth engineer to be honored was Dr. Mervin J. Kelly, retired Chairman of the Board of Bell Telephone Laboratories, Inc, recipient of the first Mervin J. Kelly Award. Since Dr. Kelly was unable to attend the fall meeting because of duties abroad, he will receive the award at the Institute's winter meeting in New York, Jan 29–Feb 3, 1961. He has been cited "for outstanding contributions in the technology of telecommunications; as a distinguished organizer and an eminent leader."

Dr. Weber, principal speaker at the General Session, delivered a speech entitled "Profession — and Engineering Education." According to Dr. Weber, "Today's society is so intricately tied to technology in all its aspects that one must wonder why the technologist has taken so little active part in government, and why so little credit — if any — goes to the engineer who creates this modern setting of society."

More on the subjects of education and engineers was discussed during other sessions. In a paper entitled, "Our Scientific and Engineering Manpower Problem," S. B. Ingram, Director of Technical Employment at Bell Telephone Laboratories, Murray Hill, N. J., declared that "we, as a nation, are facing a chronic and continuing shortage of scientific and engineering manpower." Only about 2 per cent of our graduates from college choose engineering careers. This shortage, he said, "will become more acute as time goes on."

"The demand for technical 'know-how' must inevitably increase for many decades, perhaps for centuries to come, probably at a geometric rate," Prof. J. R. Weir, of the California Institute of Technology, told a symposium on management planning aspects of future manpower shortages. His paper was titled "The Next Hundred Years."

Raising of the standard of living, he said, may possibly be determined by the number and quality of trained technologists available to the nations of the world, and this may determine the rate, "at which the underdeveloped nations can industrialize. Like it or not, the technical manpower 'shortage' will be with us from here on."

In the session on Economics of Peaking Sources, it developed that there is some basic disagreement among utility engineers. A paper by A. C. Sugden, of Long Island Lighting Co, presented essentially the same information as was described in POWER ENGINEERING's special October section. This utility has on order two 2000-kw diesel units which will be installed at the tip of Long Island to defer construction of new transmission facilities. Though they have decided not to construct the 100-Mw steam peaking-unit at the present time, their basic thoughts on the subject have not been altered.

R. D. Camburn and O. A. Lentz, of Commonwealth Associates, Inc, Jackson, Mich., submitted a paper contending that installing generating equipment specifically for peaking generation does not appear economically attractive on large systems. The basis for their study was a system with about a 60 per cent load factor and in a position to consider the addition of a unit of 150 Mw or greater capacity. In subsequent comments it

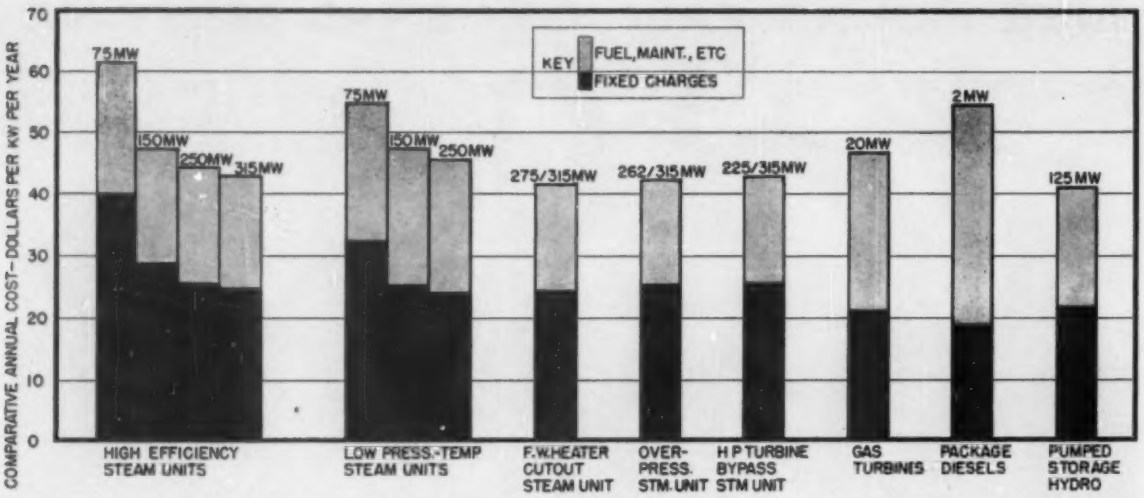


Fig. 2. Graph of comparative annual cost of various peaking power sources, from paper by R. D. Camburn and C. A. Lentz

appeared that they would also be hesitant about recommending peaking units of somewhat less than 150 Mw capacity. The only exception made was for pumped-storage hydro systems where topographical conditions are favorable.

Camburn and Lentz do not consider idle equipment as spinning reserve, regardless of start-up time, and also have some doubts about the economy of remote peaking units which are installed just to defer the construction of additional transmission facilities.

They consider large size, high-efficiency steam turbine-generators to be still the most effective way to achieve lowest cost electric power (Fig. 2), and conclude: "Since peaking units do not presently appear economically attractive on large systems, it follows that greater effort should be directed toward developing high-pressure, high-temperature steam generators, turbines and electric generators better adapted to cycling operations."

A study of cost structures for Public Service Electric and Gas Co, Newark, N. J., indicates that optimum unit sizes will ultimately approximate 1000 Mw. This study, by C. J. Baldwin and C. A. DeSalvo, of Westinghouse, and H. D. Limmer, of Public Service, found that only transmission costs prevent even larger units from being more economical.

R. W. Harmon, of The Ohio Brass Company, in a paper entitled "Effect of Bundle Conductor Field Influence on EHV Transmission Line Design," states that there is no foreseeable upper limit on transmission voltages using conventional cap and pin suspension insulators. Thus it may develop that the ultimate optimum unit size is even greater than 1000 Mw for large systems.

J. P. Jollife discussed "Present and Future Automation in the Bonneville Power Administration System." Automatic reclosing has made substations practically automatic. Fifty-three substations are under supervisory control, with the seven largest equipped for digital logging every hour. However, there is a limit to substation automation, since a minimum number of personnel must be present. This is particularly required for isolation switching, as automation does not provide sufficient safety.

One of the biggest problems is data collection and data logging on a system which covers 260,000 square miles, with the most remote generating unit over 600 miles from the control center. Most of the data is still hand recorded and processed, and most generating data comes in by teletype. Next year new equipment will go into operation, providing automatic frequency control for the largest plants.

J. Vivian, of Southern California Edison Co, discussed the Huntington Beach Automatic Steam Plant, which went on the line Oct 16, 1960. They expect one-half per cent increase in efficiency directly attributable to the use of supervisory control. The unit can be brought up to one-half load automatically in 4½ hours, while a manual start-up would take 6 hours or longer. Burners can be changed from natural gas to fuel oil in less than three minutes.

Chalmer E. Jones, of Daystrom Inc, in discussing applications of Automatic Systems to Power Plants, noted that it took 30 man-years just to program Little Gypsy Station of Louisiana Power and Light. The company recently developed a technique for eliminating expensive field servicing of electronic computer control and data logging equipment. Users of Daystrom equipment throughout the country, by means of a telephone call to a LaJolla-based console, can put their installations under the hand of an expert and have him aid in programming or in trouble-shooting faults in operation. This means that all of the skills that are available in the LaJolla laboratory are at the service of customers on a 24-hour-a-day basis.

Computer applications to power system engineering were discussed in several sessions on such topics as A Digital Approach to Power System Engineering, Optimized Transmission Tower Spotting on Digital Computer, Digital Calculations of Three-Phase Short-Circuits by Matrix Method, and Digital Computer Study of the Resynchronizing of a Turbo-Alternator.

An AIEE working group presented Application of Probability Methods to Generating Capacity Problems, in which they state that although the subject is now at least 25 years old, it is doubtful that it has reached maturity. With reliability measured in at least three different ways, and with more measures available, if needed, it appears desirable that some effort be made to compare the results obtained from these different methods.

P. L. Dandeno, of the Hydro-Electric Power Commission of Ontario, discussed Hydro-Thermal Economic Scheduling using computer techniques.

Karl A. Thallner presented A New Automatic High-Speed Grounding Switch. He states that many improvements have been made in transformers,

and, as a result, the installation of high-voltage circuit breakers may not be economically justified. A much more economic method of protecting a transformer is to trip a remote breaker with the help of an automatic grounding switch.

The two sessions on Power Generation were devoted not to consideration of conventional methods of generating electricity but to possible new methods and energy sources that show promise of supplying the world's future power requirements. These new concepts include thermionic and thermoelectric power generation, magnetohydrodynamics (MHD), fuel cells, power from thermonuclear reactions, solar energy, etc.

The case for thermionic power generation was presented in a paper by J. Coltman, of the Westinghouse Research laboratory. Mr. Coltman reviewed the basic principles of thermionics and described recent work of Westinghouse in this area. Efficiencies of 10 to 12 per cent have been attained with present devices, but with higher temperatures it is believed that efficiencies of over 22 per cent are possible. The thermionic converter is essentially a high-temperature device. Because of this it could be best applied as a topping unit for a nuclear steam plant.

Fuel cell developments were covered in a paper by J. N. Palmer, of Allis-Chalmers Mfg Co. Mr. Palmer described the fuel cell that was developed at Allis-Chalmers and used in the fuel cell-powered tractor demonstrated in October 1959. Essentially the fuel cell is an electrochemical device similar to the conventional primary battery cell except that the fuel is supplied continuously. The fuel cell can supply power as long as the fuel supply lasts. Theoretically, efficiencies of better than 90 per cent are possible, which is truly startling when compared to the best diesel engines, which are about 40 per cent efficient.

The problems involved in the development of the MHD power generator were recounted by R. J. Rosa of the Avco-Everett Research Laboratory. The MHD generator also is essentially a high-temperature device and may best be applied as a topping unit on a conventional steam turbine cycle. The MHD concept is intriguing in its possibilities for high-power, high-efficiency generating stations, but since its effectiveness depends on the use of temperatures of 5000 degrees and higher, future work will involve a great deal of materials research. A small experimental MHD generator has been built at Avco which has been operated at a power of slightly over 10 kw for short runs of around 10 seconds.

Among the most promising of the new concepts for power generation is the thermoelectric converter. This also produces electricity directly from heat, but unlike the thermionic generator, the thermoelectric generator is capable of operating at relatively low temperatures. F. W. Rosi, of the RCA Laboratories, presented an extremely interesting discussion of current development in this area of research. As Dr. Rosi pointed out, the future of this method of generation lies in the development of new semiconductor materials. The best materials that have been found to date result in efficiencies of 17 per cent, but efficiencies of 30 per cent are quite possible with better materials.

One of the most interesting discussions at the Power Generation sessions was that by John Grebe, Director of Basic and Nuclear Research, Dow Chemical Co. Dr. Grebe covered a wide range of concepts, involving nuclear reactions of various kinds. It is his opinion that our present course of nuclear energy development is too narrow and too restricted. Instead of developing power from the fission reaction, Dr. Grebe feels that we should be directing our efforts toward the utilization of the energy of thermonuclear reactions in thermonuclear bomb explosions. Various ideas have been suggested for the conversion of this explosive energy to recoverable heat. These schemes are based on the observed results of underground explosions. About ⅓ of the energy release in an underground nuclear bomb explosion is deposited in melted rock at high temperature. Dr. Grebe suggests that water introduced into such reservoirs of heat would be converted into steam which could run steam turbines. Also, Dr. Grebe explained, such explosions could be set off in deep underground coal beds, too deep to make conventional recovery methods economic.

Starting with the heat of the bomb and later with the introduction of high-pressure air and water, steam would be generated as long as there was anything combustible within reach. Dr. Grebe cited an example of a deep, wet deposit of nominally worthless coal. "We drill a good sized hole into the ground down even to one mile. We produce a vapor separating cavity, finally enlarging it by setting off a hydrogen bomb in it, at the AEC service price of a million dollars. We get fissures that intercommunicate between these various coal seams and provide a cavity which can confine pressures of 2000 psi under hydrostatic head. It is worth tens of millions of dollars."

At a press conference held shortly after his talk Dr. Grebe was questioned concerning the advisability of exploding nuclear bombs for peaceful purposes in a world that was already jittery about nuclear bomb explosions. He did not seem to feel that this was important. Indeed, he said that in accordance with such thinking we might just as well stop making large airplanes, because these also had important military applications!

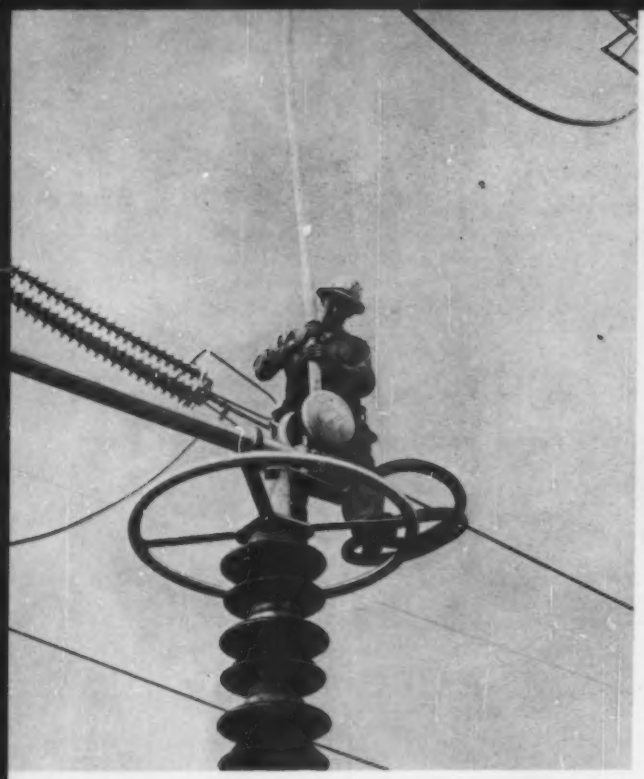
Finally, Dr. Grebe, discussed briefly the need for greater attention towards the formulation of more realistic theories of nuclear structure. His models of the various nuclear components which he demonstrated were intriguing and his idea of using the annihilation energy resulting from the interaction of an electron and a positron were stimulating indeed.

A final paper at the Power Generation sessions concerned the development of "Income" sources of power. These sources, as explained by Messrs. Benner, McClure, and Mellor, all of the General Electric Co, were sources of power now going to waste, such as tidal power, solar energy, and to a lesser extent the internal heat of the earth itself. The authors of this paper presented a historical account of the various attempts that had been made to recover power from these sources, and discussed their relative merits in terms of present-day power requirements.

J. L. Fink and T. W. Macie discussed The SCR As A Building Block in Power Conversion Systems. In their view, the recent advent of the silicon-controlled rectifier seems likely to produce a fundamental change in the power conversion industry. Circuits are considered for conversion of dc to ac, ac to dc, dc to dc and ac to ac.

Three papers were presented on the new mass warning system by H. L. Stout, R. I. Kopan and T. J. Twomey, and Arthur Laudel, Jr. The NEAR system (National Emergency Alarm Repeater) is a mass warning system using the electric utility networks for signal generation and distribution. Only a relatively small percentage of radios are on at a given moment, but electric power lines service 96 per cent of the total population (99 per cent in critical defense areas). The NEAR system will actuate a special receiving device which remains plugged into any power receptacle. The population could then be warned by a sound from the receiving device that they should turn on a radio or television set for detailed instruction.

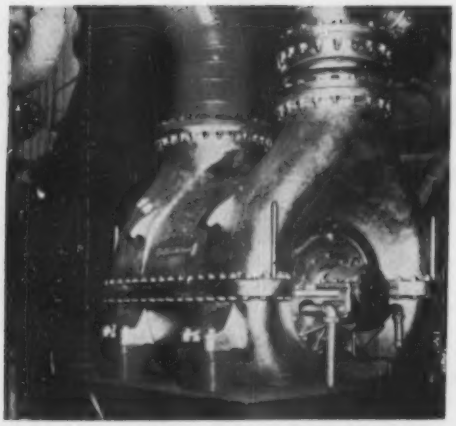
A total of nearly 350 technical papers were read in the course of the sixty sessions. THE END



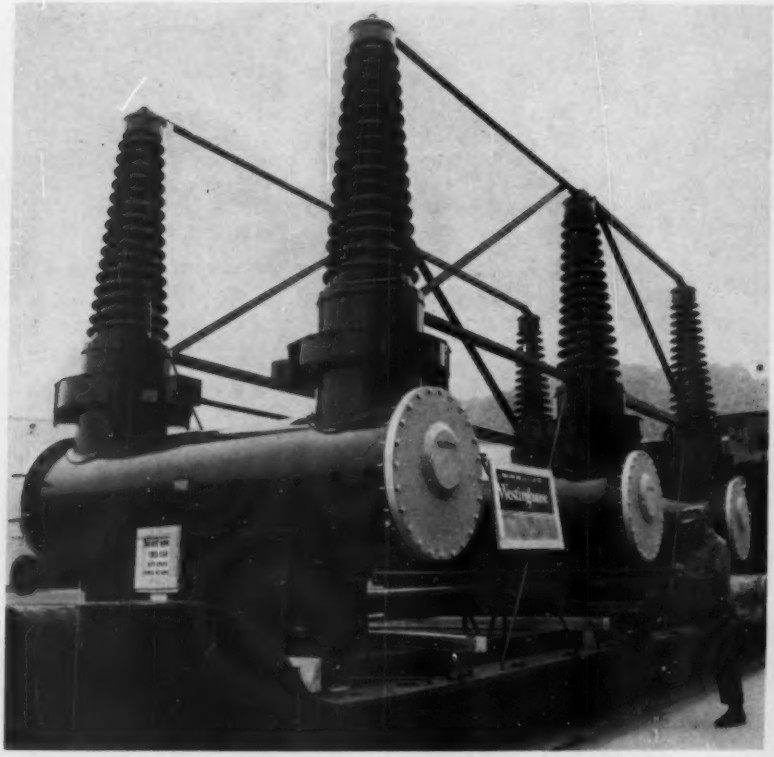
Lebanon, Ohio, steps up power output with this 16-cylinder, 4480-hp generator made by Cooper-Bessemer. The compact engine is received at power plant

460-kv line of Pennsylvania Electric Co uses aluminum conductor larger than any yet made in the U. S. for an electric line. Here the 2.32-in. diam conductor is fitted to top of 23-ft high bushing at Saxton substation

Power Engineering's

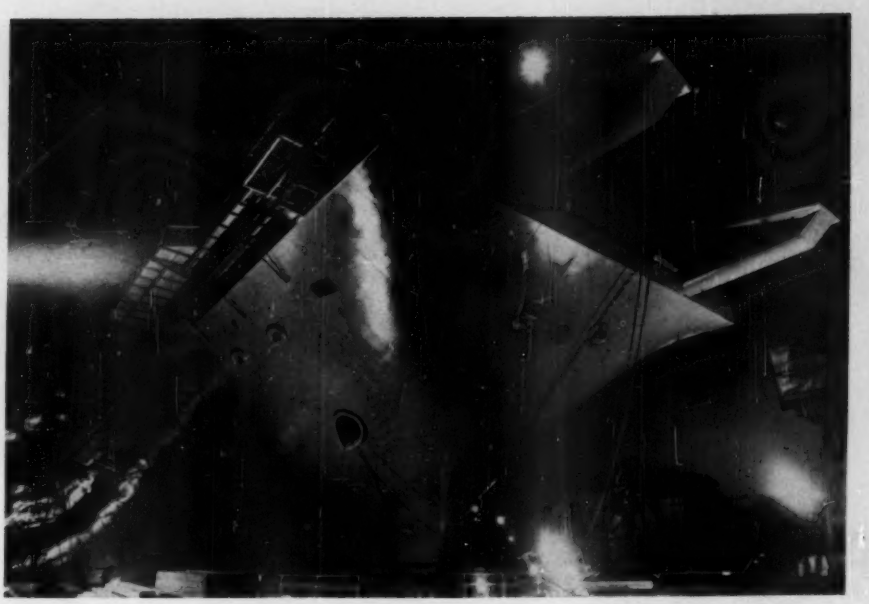


1399-day run of continuous, trouble-free service is record of these 22,500-cfm Ingersoll-Rand turboblowers at Esso's Baton Rouge refinery. They have been in service at the plant over 16 years

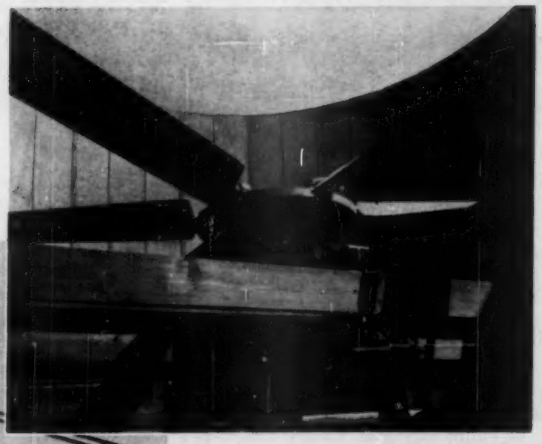


230-kv circuit breaker which uses sulphur hexafluoride (SF_6) instead of oil leaves Westinghouse plant for Brunner Island station of Pennsylvania Power & Light Co. It's the first such unit

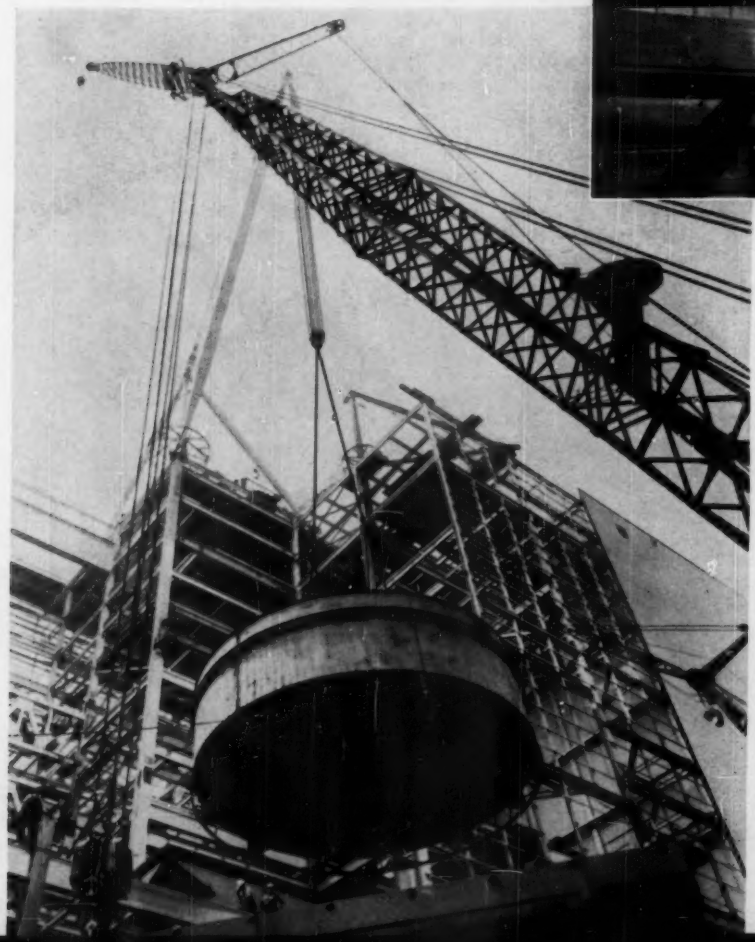
NEWS REEL



Aircraft carrier Enterprise will have a nuclear propulsion plant capable of driving ship at speed of over 25 knots. Biggest ship ever built, the Enterprise will have 8 reactors to supply power to drive 4 propellers each the height of a two-story house. Westinghouse made the reactors



Big breeze stirrer-upper can displace nearly 1,000,000 cfm. It's one of 4 Koppers Aeromaster fans made for cooling tower of AEC's new Experimental Breeder Reactor recently built near Idaho Falls



Raising the rotor of one of the three Ljungstrom air preheaters made by Air Preheater Corp to serve the new No. 6 boiler unit of Wisconsin Electric's Oak Creek plant. They will receive incoming air at 190 F, preheat it for combustion to about 510 F. Boiler is a 1,780,000 lb/hr unit

HOW BRASS MILL CONTROLS WASTES

GROWTH OF TITAN METAL MFG. CO'S PLANT HAD PRODUCED 90-ODD SEWER OUTFALLS. RESULT: A NEW TREATMENT SYSTEM, WITH WASTES SEGREGATED FOR ECONOMICAL HANDLING, AS DESCRIBED HERE BY W. M. RUMBERGER, CHIEF CHEMIST

IN COMPLIANCE with the Pennsylvania clean streams program and anti-pollution legislation of the Commonwealth of Pennsylvania, Titan Metal Manufacturing Co, Division of Cerro de Pasco Corp, has constructed two industrial waste treatment plants during the past five years.

Titan's six manufacturing units are located in the geographical center of Pennsylvania and in an area where trout fishing is an important recreational activity. As a result of this, stream conditions are constantly under the surveillance of sportsmen and the State regulatory agencies.

Comprehensive stream studies and plant studies were made during the years 1952 to 1955. Composition studies and flow studies were made at each of the six plants which comprise Titan's manufacturing units.

As a result of this work, 90-odd sewer lines were found to be discharging industrial wastes, process and cooling waters into Logan Branch and Spring Creeks. Effluent from the plants was found to contain excessive quantities of copper, hexavalent chromium, and trivalent chromium, and free mineral acidity.

In-plant studies revealed, as was expected, that the primary sources of contamination were rinse waters from pickling operations and periodic dumping of spent acid and alkaline cleaning solutions.

The information gathered as a result of these studies was used in the design of a proposed waste treatment process and also in the design of a segregated collection system. At this point of the program considerable effort was made to segregate wastes requiring treatment from those not requiring treatment, such as cooling waters, roof drains, etc.

The first waste treatment plant was constructed in 1955 at Titan's

Fig. 1 (above). General view of main treatment plant for waste waters. In foreground, sulfur dioxide tanks and sumps that collect segregated wastes

Fig. 2. In foreground is the clarifier, then equalization tank, with concentrated acid storage tanks in background

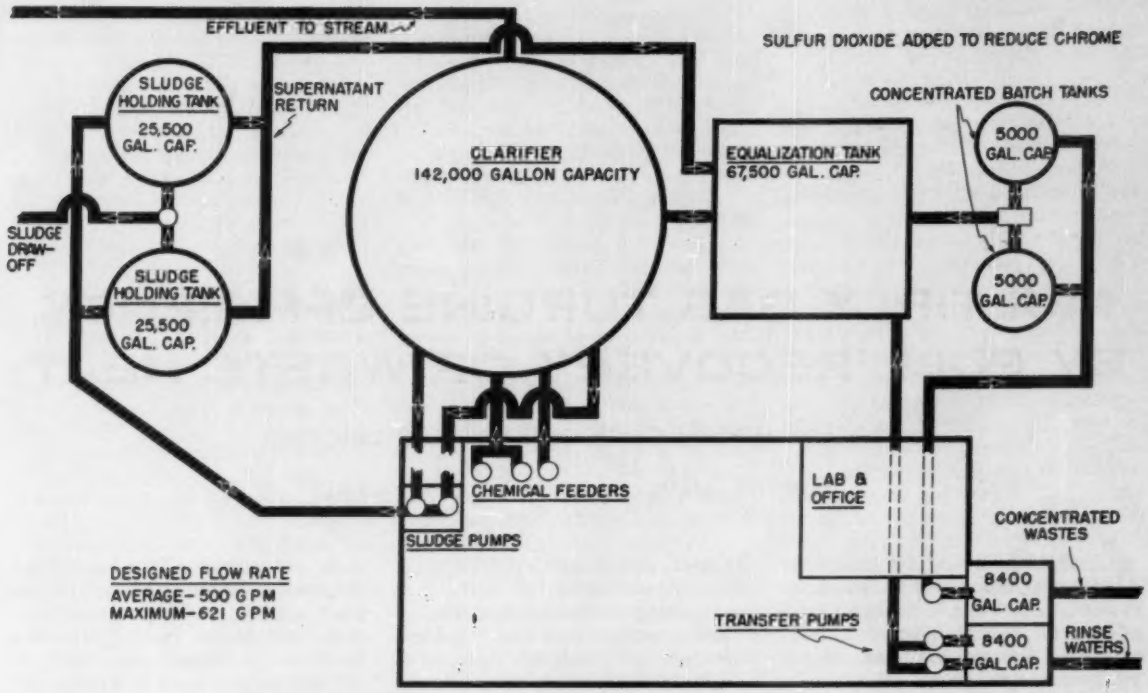


Fig. 3. Flow diagram of Titan Metal's industrial waste treatment plant. Last year, over 90,000,000 gallons were processed

Plant No. 5, an outlying wire mill. This unit served as an experimental and pilot operation and was used in preliminary studies on neutralization and chromium reduction.

The pilot unit later served as a full-time treatment and disposal plant for industrial wastes originating at the Plant No. 5 operation.

Data obtained from this experimental operation was used in the design and construction of the main industrial waste treatment plant, which was constructed during the years 1957–1958.

Industrial wastes generated in the manufacture of copper base alloy products are generally of two types. The first and largest volume is generated from the various rinse tanks connected with acid pickling units. The second type covers concentrated pickling and cleaning solutions which are discharged when spent.

Collection System

Each type of waste water is handled in its own collection system. Main system is approximately 3420 feet long, and consists of a rinse water collection sewer, a concentrated acid collection sewer, and a sanitary wastes sewer. Rinse water mains are constructed of terra cotta pipe with wedge-lock joints, while plastic material was selected for the concentrated acid collection system. These materials were decided upon after many months of research on the corrosion resistance of the materials to Titan's waste waters. Manholes are located approximately every 400 feet to facilitate periodic checks and clean-outs.

Flow Rates

The design flow rate for the main treatment plant is 500 gpm with the maximum of 621 gpm. Daily average flow since the plant was put into operation has been approximately 250 gpm. These flow rates represent waste water originating at Titan Plants Nos. 1, 4, and 6.

During the period of January 1, 1959 to July 1, 1959, 213,000 gallons of concentrated acid and 37,461,000 gallons of rinse waters were treated and discharged into the streams of the Commonwealth of Pennsylvania. Treatment is continuous and strict laboratory control is maintained on the effluent at all times.

Chemical Treatment

The waste waters generated by Titan plants contain excessive quantities of copper, chromium, zinc, and free mineral acidity. The concentrated acid wastes containing chromium are reduced using sulfur dioxide. Reduced material is then introduced to the equalization tank at a specifically controlled discharge rate. There it is mixed with rinse waters which are continuously flowing through the same tank. The resultant mixture, after a specific retention time, is neutralized with a lime slurry and the metals precipitated as hydroxides.

The entire reaction is monitored and recorded by instrumentation. After being neutralized, waste waters are clarified and the effluent discharged into the adjoining stream.

Sludge from the clarification unit is concentrated by settling and the supernatant returned to the equalization tank. Sludge is transported by tank truck to two large lagoons which are located in the adjacent countryside.

General Operation

The main treatment plant has been in full operation since October, 1958 and is operated 24 hours a day, seven days a week. The plant is currently staffed with an operator and a laborer who are responsible for operations and maintenance. Since this is essentially a chemical process, the entire operation is under the supervision of Titan's Chemistry Department.

Daily chemical analyses are made on the effluent discharged to the Commonwealth's waters and are submitted to the area Department of Health offices on a monthly basis.

During 1959, 90,069,400 gallons of industrial waters were processed in this new system. THE END

MULTIPLY GAS TURBINE EFFICIENCY BY FULL RECOVERY OF WASTE HEAT

WILLIAM MORAIN OF COOPER-BESSEMER DESCRIBES VARIOUS WAYS OF UTILIZING WASTE HEAT

ALL HEAT ENGINES have substantial losses which cannot be avoided. Losses due to improper combustion or to heat rejected to coolants and the surroundings can be minimized by proper attention to combustion details and careful design. But losses due to high temperature products of combustion which leave in the engine's exhaust are not subject to substantial reduction.

Exhaust waste heat ranges from about 25 per cent of energy in fuel, for efficient diesel engines, to more than 80 per cent for the simple-cycle gas turbine. Putting this sensible heat to work results in large gains in over-all efficiency.

Gas turbines require a high airflow rate for temperature-limiting purposes, which results in large quantities of combustion products. Per horsepower developed at turbine shaft, 50 to 70 pounds of exhaust gas are produced per hour. Stack temperatures of 700 to 900 F are common. Assuming a final stack temperature of 400 F, recoverable heat ranges from 4000 to 9000 Btu/hr per horsepower produced by the turbine.

Utilizing Waste Heat

Many ways are used to recover or utilize this waste heat:

1. Heat returned to cycle or process by means of heat exchangers.
2. Heat utilized independently to generate hot water or steam, to regenerate catalysts or adsorbers, or to furnish heat to a process.
3. Exhaust used as preheated combustion air for a boiler. This is quite feasible since exhaust still contains about 75 per cent of the oxygen in the original combustion air. Gas turbine then serves as air preheater and forced-draft fan.
4. Exhaust used to generate steam for combined gas-steam turbine cycle. Supplemental firing is usual, and many configurations are possible.

Both recuperative and regenerative types of equipment are used. Load schedule of the turbine must be taken into account, and heat exchanger surface may have to be tailored for prevailing loads. Low use factor or too much part-load operation may complicate the fouling problem.

Steam or hot water generated by waste heat may be injected into the combustion chamber of the gas turbine. Saturated steam at 200 psia permits a load rating increase of 35 to 40 per cent, with attendant reduction in net station rate from 16,300 to 14,600 Btu/hr for one particular application (see POWER ENGINEERING, June 1959, page 93).

Heat exchangers and waste heat boilers usually cause back-pressures on the order of 8 to 14 inches-water. This is an important consideration since shaft horsepower will fall about one per cent for every 2 in.-water increase in back-pressure; but over-all thermal efficiencies on the order of 40 to 70 per cent may be realized.

Gas turbine exhaust use as preheated combustion air permits the highest of all waste heat recovery rates. Practically all sensible heat in the exhaust gas is utilized, making over-all thermal efficiencies of 90 to 95 per cent realizable. Such a boiler adds about 75 per cent to base turbine costs, but the large gains involved are worth considering.

Industrial Applications

Union Carbide, at its Texas City plant, required more power, steam and compressed air — especially air. The choice of compressor drive was narrowed to that of either a gas engine-driven reciprocating compressor or a gas turbine-driven centrifugal compressor. While both solutions had their merits, the low thermal efficiency of the gas turbine seemed a most serious disadvantage. Still, its simpler maintenance and wide fuel tolerance were considered most attractive. This led to a search for some way to capitalize on the turbine's inefficiency or turn it to advantage.

Use of the turbine's exhaust for preheated combustion air for a necessary new boiler was then explored. It was found that the boiler could be converted to such a scheme for only 10 per cent increase in the original cost. The flue gas passage area had to be increased, and an economizer was installed in place of the air preheater.

Increases Made

These changes increased boiler capacity by 25 per cent, and the ready supply of high-pressure steam permitted an increase in the steam turbine generator's rating from 7500 kw to 9375 kw. Over-all thermal efficiency of the gas-turbine boiler combination was 77 per cent, the gas turbine showing an apparent increase from 17.2 per cent to 74.8 per cent, while the boiler efficiency rose from 80.6 per cent to 81.6 per cent. Calculations indicated that substantial increases in boiler capacity were readily available for small increases in turbine back-pressure. This, of course, became a matter of balance of steam power versus gas-turbine power. Figures 1 and 2 show the comparison between separate and combined gas turbine and steam plants.

Adding a gas turbine to provide for extra load, and using the turbine's exhaust to heat feedwater for the entire plant, can result in significantly improved over-all plant efficiency. At Oklahoma Gas and Elec-

tric Co, the first such installation was successfully put into service. Two gas turbines added 9500 kw to the station's output at their own shafts. In addition, the steam plant's output was increased 4500 kw, or nearly 10 per cent, since feedwater heating was taken over by waste heat. The over-all plant rating thus became 65,000 kw, and over-all efficiency of the entire plant was raised about 5 per cent.

The Gates Rubber Co has an interesting, combined gas-steam turbine installation, where a 5000-kw gas turbine generator exhausts into a waste heat boiler, with supplemental firing (see POWER ENGINEERING, Oct 1957).

Monroe, Louisiana installed a 10,000-kw gas turbine in July 1958. Its intended use is for operation in conjunction with a 16,500-kw steam turbine generator. When the units are combined as planned, the over-all efficiency is expected to be as much as 10 per cent higher than might have been obtained with an all-steam plant of comparable power. (See POWER ENGINEERING, May 1959, page 77.)

At the Fawley refinery, an English Electric gas turbine is used in a petrochemical plant. The open-cycle, non-recuperative, two-shaft gas turbine is rated at 2625 hp at 7500 rpm, with an 80 F ambient. Steam cracker gas fuel, heating value 1040 Btu/cu ft, is burned at a rate of 15 standard cu ft per bhp/hr, resulting in a thermal efficiency of about 16.4 per cent and exhaust flow of 43 lb per sec.

A waste heat boiler of single-pass, shell and tube design was added to make 18,000 lb per hr of steam at 175 psig. The over-all thermal efficiency of the gas turbine and boiler combination then rose to over 60 per cent at full load.

Westinghouse describes an unusual cycle in which the combustor for the gas turbine is in the boiler. Compressor air is delivered to the fire box of the boiler, which operates at a little under 5 atmospheres pressure (see POWER ENGINEERING, Aug 1958, page 97, and Oct 1957, page 79).

Advantages

In discussing the same cycle, where the boiler serves as the gas turbine's combustor, General Electric engineers list the following advantages:

A. Over-all efficiency increase of 4 to 8 per cent.

B. An increase in net plant output for a given steam flow to the steam turbine of about 15 per cent (gas turbine's output).

C. Marked reduction in size and cost of steam generator equipment for a given steam flow (pressurized boiler) and reduced size of turbine, condenser and auxiliaries for a given plant output. Also forced- and induced-draft fans eliminated. Auxiliary power demands may be reduced by 1.5 to 2 per cent.

Magnitude of the improvement in the net station heat rate depends upon the basic steam cycle with which a comparison is made, initial gas turbine temperature and arrangement of heat recovery equipment.

For example, consider a 133,500-kw, combined gas-steam turbine plant, where the steam turbine delivers 115,000 kw using steam of 1800 psig, 1000 F initial temperature, 1000 F reheat, and with 2 in. Hg abs condenser pressure, while the gas turbine is rated 18,500 kw at 1450 F inlet temperature, 5.43 atm. The compressor discharges at 497 F, 5 atm to the boiler, where all combustion takes place. Figure 3 shows the comparison in net station heat

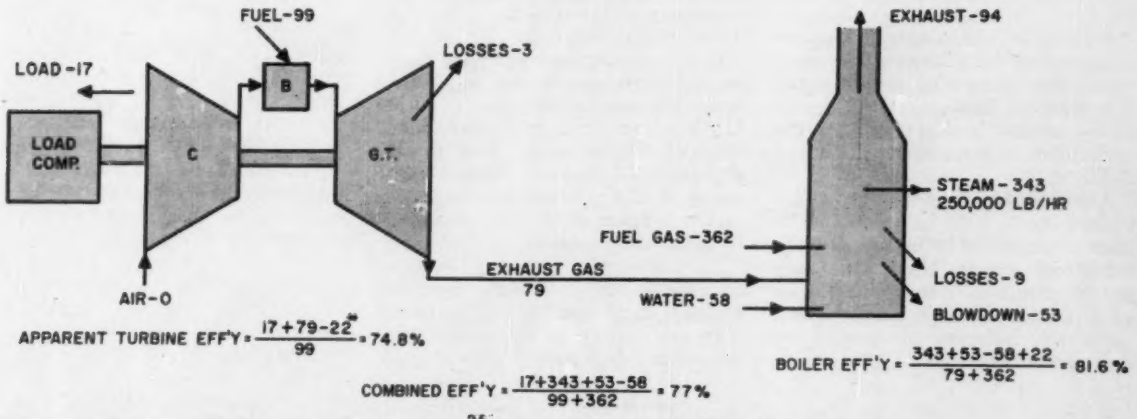
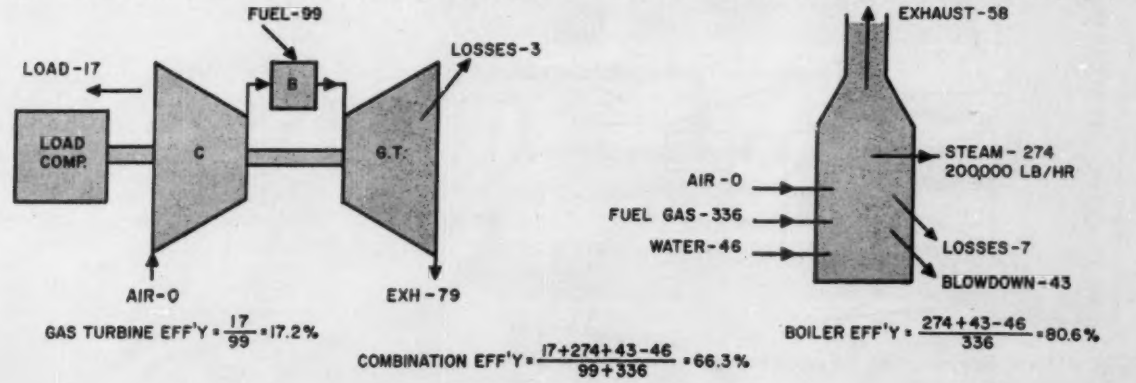


Fig. 1 (above). Union Carbide Study, separate gas turbine and steam plant. Fig. 2. Combined gas turbine, steam plant



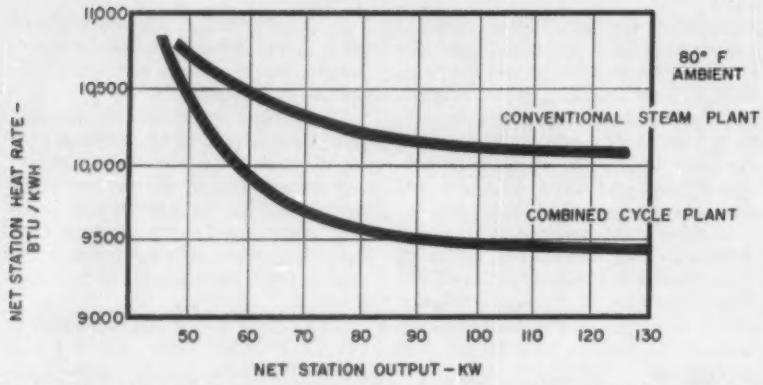


Fig. 3. Gas-steam turbine plant compared with conventional 133,500-kw steam plant

rate with a 133,500-kw steam turbine plant operating under identical steam conditions. The boiler is gas-burning, with 10 per cent excess air at full load. The curves show an improvement of 6.1 per cent at full load, with a maximum of 6.4 per cent at 57 per cent load. If this comparison were made for a 4500-psig, 1100 F steam plant with 1050 F and 1000 F reheat, the improvement would only have been 4 to 5 per cent. On the other hand, the improvement would have been 8 or 9 per cent if the steam conditions chosen were 850 psig, 950 F.

Another way of looking at it would be to say all the kilowatts developed on the gas turbine shaft are generated at a 3650 Btu heat rate, since almost all the exhaust heat is utilized in the cycle. This is graphically illustrated in Fig. 4.

A survey of the literature shows gas turbine waste heat being applied to most of the major industries. Even in non-steam plants, there are many process uses, and in several instances such as oil refineries and cement work, the incoming stock may require preheating.

Around oil refineries, the fact that gas turbines can operate on fuels of lower quality than other types of prime movers should be carefully considered. When this is coupled with full utilization of the waste heat, remarkable economies are possible. In one refinery, the following results were obtained on a gas turbine with exhaust gas heat exchanger:

Turbine hp at 80 F ambient	1265
Fuel heat rate, MMBtu/hr	20.50
Heat equivalent of shaft power, MMBtu/hr	3.22
Normal exhaust temperature, F	840
Stack temperature, F	400
Heat recovered from exhaust, MMBtu/hr	10.27
Gas turbine thermal efficiency, %	15.7
Over-all thermal efficiency, %	65.8

If the exhaust gases had been used as preheated combustion air for a boiler, the total sensible heat of 16.75 MMBtu per hr might have been utilized. Theoretically, this would represent an over-all thermal efficiency of 97.5 per cent, and in actual service a figure of 90 per cent would be quite within reason.

In the cement industry, heat is required to bring about the chemical changes which take place in the kilns. The gas turbine is not widely employed in this industry, but the utilization of its rich exhaust gas should create definite interest.

In the copper industry, heat is required for roasting and smelting. Electric power is required for refining. The roasting (burning off of sulfur in ore) requires about 500,000 to 700,000 Btu per ton of ore, and is usually performed at 1290 F to 1390 F. Smelting requires 3 to 3.8 MMBtu per ton of ore, and takes place at 2300 F. Such temperatures are available with supplemental firing. If gas turbines were used to generate power for the refining process, the waste heat could be put to work in roasting and smelting, with high over-all efficiency.

The steel industry is another potential customer for waste heat. One ton of steel requires the expenditure of 39.1 MMBtu. This is usually supplied in the form of coke and waste gases. However, a gas turbine-driven blast furnace blower would find plenty of use for the exhaust gas (see POWER ENGINEERING, Oct 1957, page 80). Large amounts of power are required for the various soaking, blooming and finishing mills, and combined gas-steam turbine cycles could be profitably employed.

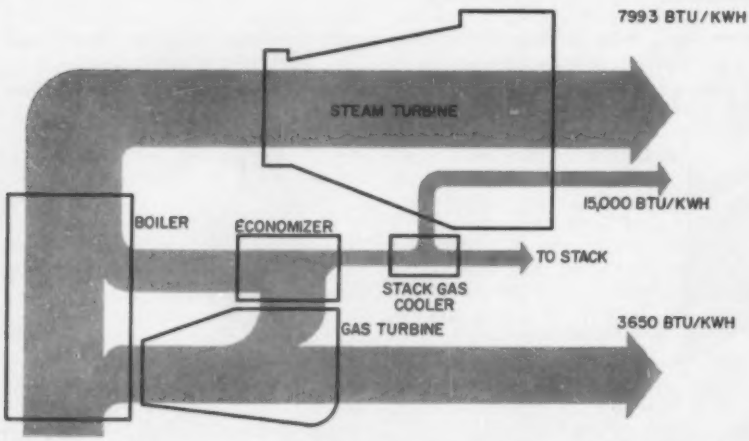


Fig. 4. Heat flow diagram for combined gas-steam turbine plant, 133,500 kw

Important Considerations

For any industry, the highest possible profit margin is the primary objective. This is a more important consideration than any theoretical yardstick such as high thermal efficiency. An examination of existing waste heat installations indicates that anticipated efficiency gains are consistently being realized and that installation and maintenance costs are not excessive. In fact, putting waste heat to work is already regarded as a must in many of the larger industries. The gas turbine with its high mass flow and high-temperature exhaust fits neatly into this picture, and it is only in the case of very small plants that any question exists as to the economic balance.

With the development of high efficiency, inexpensive rotary regenerators, even one million Btu per hr of waste heat may be worth reclaiming. There can be little doubt that tubular recuperators and waste heat boilers are economically justified in the range of 10 to 15 million Btu per hr and above. In preparing waste heat studies, the entire plant should be carefully considered for ways of utilizing this heat.

There may be more heat available than needed at first glance, but it is surprising how many uses for heat can be found with a little study. The rewards are in direct proportion to the quantities of heat which are recovered. THE END

ELECTRIC ARC HEATER TO OPERATE AT UP TO 30,000 KILOWATTS INPUT

WIND-TUNNEL VELOCITIES OF TEN TIMES SONIC FORESEEN BY USE OF NEW ELECTRIC ARC HEATER

A MACHINE with the potential capability to supply a stream of gas at temperatures as high as 20,000 F and pressures as great as 15,000 psi has been devised by the Westinghouse Electric Corporation. The arc heater has immediate application in a wind tunnel for missile testing, and it holds promise as a chemical synthesizer and as a furnace for processing metals with ultra-high melting points. A prototype model of the machine has been operated at a power input of 1700 kilowatts, but a high of 30,000 kilowatts is planned by the company.

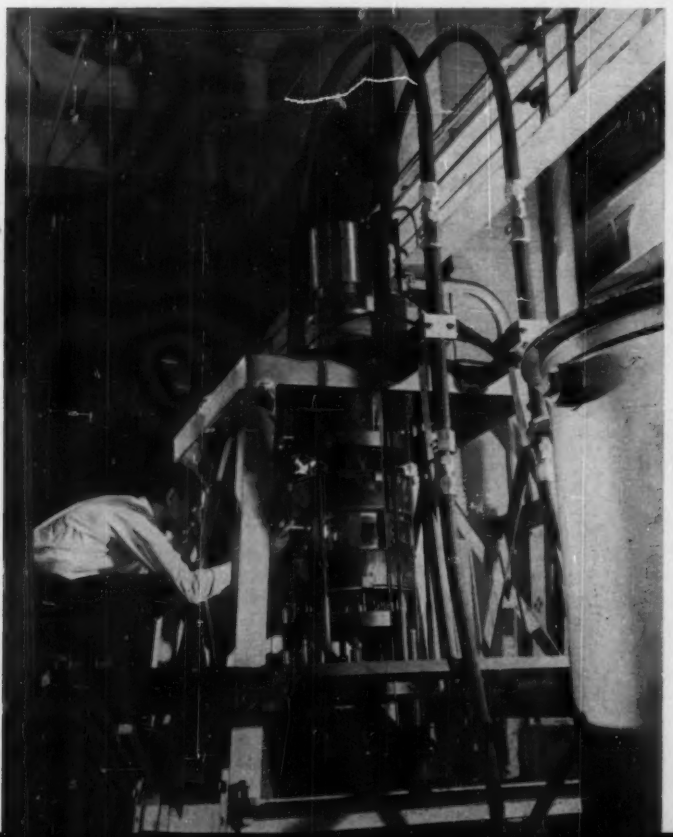
Temperature into the nozzle has been maintained at 10,000 degrees, and flow from the nozzle of the unit has reached a velocity of 3400 miles per hour. Velocities over ten times the speed of sound can be expected when the gases are expanded with a hypersonic exhaust nozzle.

Success of the arc heater is greatly dependent upon a low level of contamination. One of the problems involved in units under development during the past two years is that electrodes and walls of the chamber burn and thus contribute impurities amounting to as much as 10 per cent of the mass of the gas flowing through the system. The new unit has a guaranteed maximum contamination level of 0.2 per cent.

Each electrode consists of a hollow donut-shaped ring placed horizontally, one directly above the other. An electric arc is started by drawing it across the gap between the two rings, and then rotated around the gap at a high rate of speed by means of a magnetic field from d-c coils arranged around the outside of the heat chamber. This rotation, combined with water-cooling, prevents the electrodes from heating to a point beyond the structural endurance of the material.

Advances in arc-heater technology should permit offering equipment to the metal, chemical and petroleum industries within one or two years. It will find applications wherever gases at extremely high temperature and pressure can be used to advantage. Presently, these industries have no practical means of producing temperatures of 10,000 to 20,000 F in gases at high pressure over a sustained period of time.

Depending on wind-tunnel-facility power requirements, an arc heater with its power supply may cost from $500,000 to $1,500,000. THE END



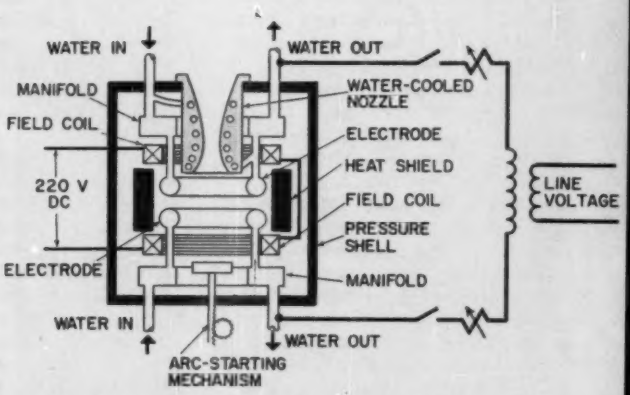


Fig. 1. Cross-sectional view of the arc heater

Fig. 2. Prototype arc heater, designed for 1.2 lb-per-sec flow, should supply gas at 1500 psi, enthalpy of more than 2000 Btu per lb for as long as 10 min without measurable contamination

NATIONAL POWER CONFERENCE MEETS IN PHILADELPHIA

ENGINEERS IN AIEE AND ASME MEET TO DISCUSS PROBLEMS COMMON TO THE POWER INDUSTRY

POWER ENGINEERING subjects, both mechanical and electrical, provided the agenda for the National Power Conference held recently by ASME and AIEE. Authorities in both these fields of engineering presented some excellent papers at this meeting. Interest in the subject matter was evidenced by the very large attendance.

Highlighting the session were talks given by the presidents of both societies. Clarence H. Linder, of AIEE, made a very thought-provoking talk on *unification of effort among engineering societies.* He discussed the need for more joint sessions, such as the National Power Conference, and stated some excellent reasons for his opinion. The cost (and time) expended in exhibiting, entertaining and traveling to all of the meetings is becoming exorbitant.

Manufacturers are forced to cover two, three or four conference and show meetings just to reach the audience they expect to reach. Also, companies are being forced to stand the expense of sending their engineers to a number of conferences just to permit the man to get all of the engineering information required in his job.

Mr. Walker Cisler, president of ASME, discussed advancements in the art of steam generation — as Carnot predicted it. It was a most interesting talk and was well enjoyed by all of the audience. (And Carnot would be delighted with the power field today.)

The general fields of power engineering covered in this session were as follow: Coördination of generation, transmission and operation; service requirements for industrial customers; advancement of power engineering; power plant automation; and advances in economic power production.

Power Automation

Power automation was, of course, the most popular subject to all in attendance. Two excellent papers were given on actual automated plants: These related to the Huntington Beach and Little Gypsy installations. W. L. Chadwick, of Southern California Edison Company, and W. T. Hess, of Louisiana Power & Light Company, gave strong justification for the cost of installing complete automation systems in their respective plants. The consensus was that cost is justified in *protection to the equipment;* and it is not on a manpower-savings basis.

It appears that the trend toward total automation in power plants will proceed cautiously and will come first in those plants designed for higher pressures and temperatures. This is logical because those stations are most critical to monitoring, and control of, such a complexity of operational details. Hardware to supplement computers is still the limiting factor. Many improvements have to be made before all of the "bugs" are out of these accessories.

Boiler explosions and boiler-burner-controls appeared to be of great importance to most of the members of the conference. Much remains to be done in the perfection of flame-failure detection equipment, although great strides have been made recently.

Increase in steam temperature for large generating stations came in for considerable discussion also. Apparently the metallurgy of metals for boiler tubes is going to hold back further temperature increases for some time to come. The cost of austenitic steels is prohibitive for further temperature increases, according to some of the experts.

Need for a better understanding of industry's electrical requirements occupied one session of this conference. Some excellent papers told what must be done to give industry the best service reliability (and rate structures), and what the power companies are doing to provide this.

Four papers were given on the general subject of coördination of plant and transmission facilities. All tended to show the continuing interest in this field and the ultimate savings

that will result to all utilities in the proper coördination and pooling of facilities.

Ross Forney, vice-president of Forney Engineering Co, had some most interesting remarks on the subject of Boiler Burner Control Systems. He stated that the engineer cannot relax on any phase of component selection. It is not enough to purchase the most expensive equipment available; it must be selected with regard to its actual field experience in this particular type of service, stated Mr. Forney.

Further, he stated that it is necessary to recognize that for some functions there are no reliable components developed to date. And, in this case, the engineer must get around the problem by selecting another design for which a reliable component is available.

G. W. Kessler, chief engineer of Babcock & Wilcox Co, gave a paper entitled "Automation — The Application of Computers to Automatic Boiler Operation." This paper explained what problems are involved in applying computers to boiler operation in large plants. He pointed out that there are still weak links in certain loops in the automation complex.

Specifically mentioned were pressure switches, equipment requiring contactors and relays, solenoid valves, gas analyzing equipment, flow-measuring equipment and sampling equipment. These were discussed in some detail, and all must be perfected to a greater degree to offer complete and reliable automation.

Another paper on Computer-Controlled Generating Plants was prepared by Gaines, Spielberg and Kennedy, all of General Electric Co. This excellent paper discussed the complete *systems approach* and gave a general workable description of the steps involved in automating a complete plant.

Automation Topics

The next automation paper covered in rather complete detail the following main subjects:

1. Definition of the problem and scope of the work; 2. organizing the team; 3. preparing the specification; 4. system design, fabrication and test; and 5. system application follow-through. This paper in effect is a condensed primer on what should be done in selecting automation equipment for a power plant.

Robert Worley, chief power engineer of United Engineers, delivered an excellent paper on "Industry's Need for Quality Electric Power Service." In this paper, Mr. Worley pointed out the present-day needs of industry for reliable service. This discussed not only voltage and frequency regulation, but the need for stand-by power in certain industries. It was a very informative paper and stressed the fact that utilities are becoming more aware of industry's requirements today.

In the field of thermal efficiency, P. H. Knowlton, of General Electric Co, furnished a very interesting paper on how the electric industry is seeking to obtain a 40 per cent thermal efficiency, or better. In addition to the basic steam cycle, the paper discussed various other combinations, including the fuel cell, thermoelectric devices, and thermionic equipment. It pointed out that the constant striving for higher efficiency will ultimately encompass all of these methods in one combination or another.

Noyes and Davidson, of Westinghouse, presented a paper on Steam Turbine-Generator Automation. This paper gave a very thorough analysis of the many points of scanning and control which the turbine alone requires in the modern large steam generating plant. As generators have become more complex and require more accurate scanning and controls, automation appears ultimately to be the only answer to proper, safe turbine operation. THE END

ASME President Walker L. Cisler

AIEE President Clarence H. Linder

FLOATING POWER IN THE ARCTIC

METCALF AND EDDY'S PROJECT ENGINEER, JAMES A. FIFE,

TELLS HOW A COMPLETE POWER PLANT WAS FLOATED TO GREENLAND

EARLY IN 1958, the U. S. Air Force was faced with the problem of providing a large amount of power for a Ballistic Missile Early Warning Station (BMEWS), which was then in the planning stage, and which was to be located near Thule, Greenland. Time which could be devoted to construction was severely limited, yet the reliability requirements of BMEWS indicated a high-quality power source.

The Engineering Division of the Directorate of Civil Engineering, USAF, made a survey of various types of mobile power-generating equipment, in the Department of Defense inventory. This survey indicated the possibility of using a vessel, or barge, as a base for power generating equipment.

Further investigation resulted in a solution to the problem which has proved to be both economical and successful from the standpoint of reliability. The answer was found in the U. S. Navy's inventory of *floating power plants*.

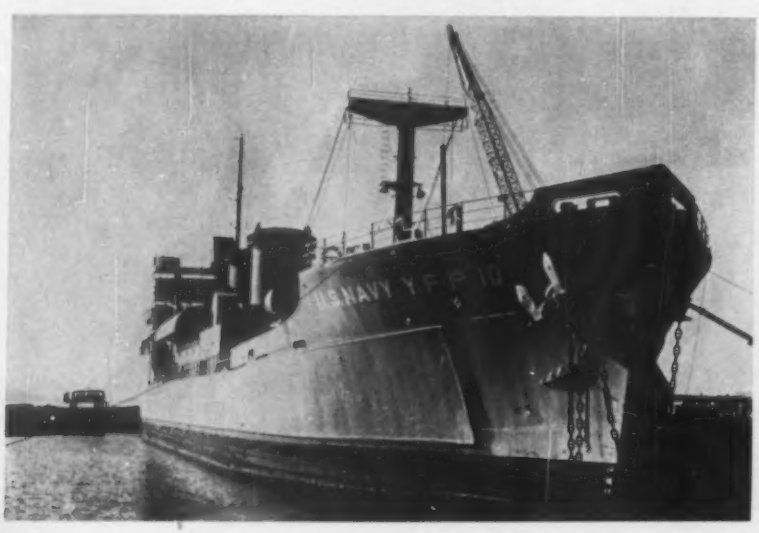
The vessel in question is the YFP-10, a floating power plant capable of providing 29,000 kw of power while exporting 115,000 pounds of steam per hour — currently berthed at Thule, Greenland.

This ship provides power to the Air Force long-range radar facility and power and heat to the Thule Air Base. The project was designed by Metcalf and Eddy, under contract to the Corps of Engineers, based on detailed criteria from the Directorate of Civil Engineering of the U. S. Air Force.

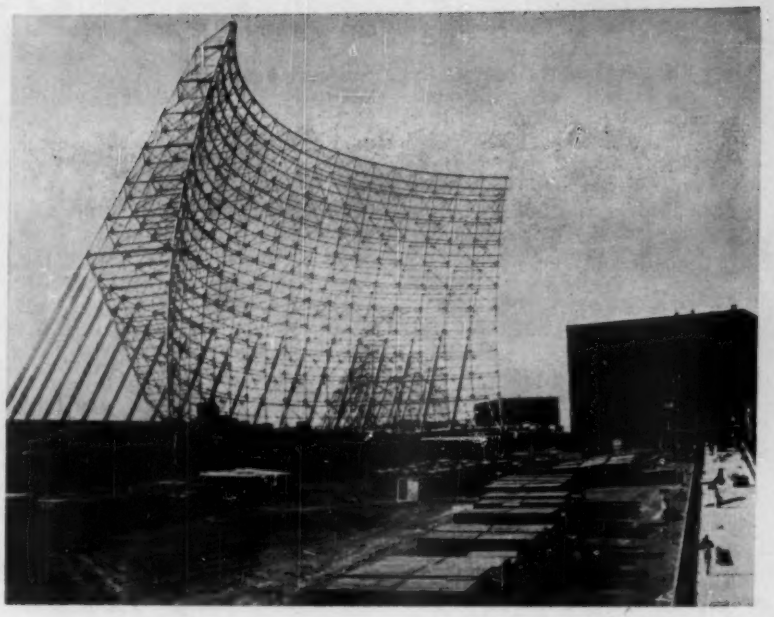
Prior to the Arctic assignment, the YFP-10 was on lease to Florida Power and Light Co, and berthed at Fort Lauderdale. To service the Thule base, it was necessary to provide the ship with environmental protection, a semi-permanent mooring system, and connections to the various base utilities systems. Also, provision had to be made for the continuous circulation of sea water about the ship for condenser service, and conversion of the ship's steam system.

Ship conversion and winterization took place at the Bethlehem Steel Co shipyard at Hoboken, New Jersey. Included were the application of hull insulation, revision of the fuel system, and modifications to provide for the export of steam.

In the design and siting of berthing facilities, the prime consideration was Thule's severe environmental conditions. Along with 24-hour darkness, winter brings temperatures of 35 to 40 below zero and winds in excess of 100 miles per hour, with the harbor freezing to a depth of 6 ft. With the



Ship in berth at mid-summer, and completed closure of lagoon's harbor end



View of the BMEWS radar site, powered by YFP-10. Antenna structure, one of four, is 400 ft across, 165 ft high

advent of summer, there is 24-hour daylight, temperatures reaching into the 50's, and the threat of pack-ice being blown on shore. Water temperatures in the harbor range from 29 to 35 F.

Ship YFP-10 is 340 ft long, having a 50-ft beam and a displacement of 7000 tons when fully loaded. All propulsion machinery has been removed. Basic units of the YFP-10 comprise three Foster Wheeler Type-D, top-fired, oil-burning steam generators with superheaters, plus the usual auxiliaries. Each steam generator has a normal rating of 123,000 lb of steam per hr, at 625 psig and 830 F.

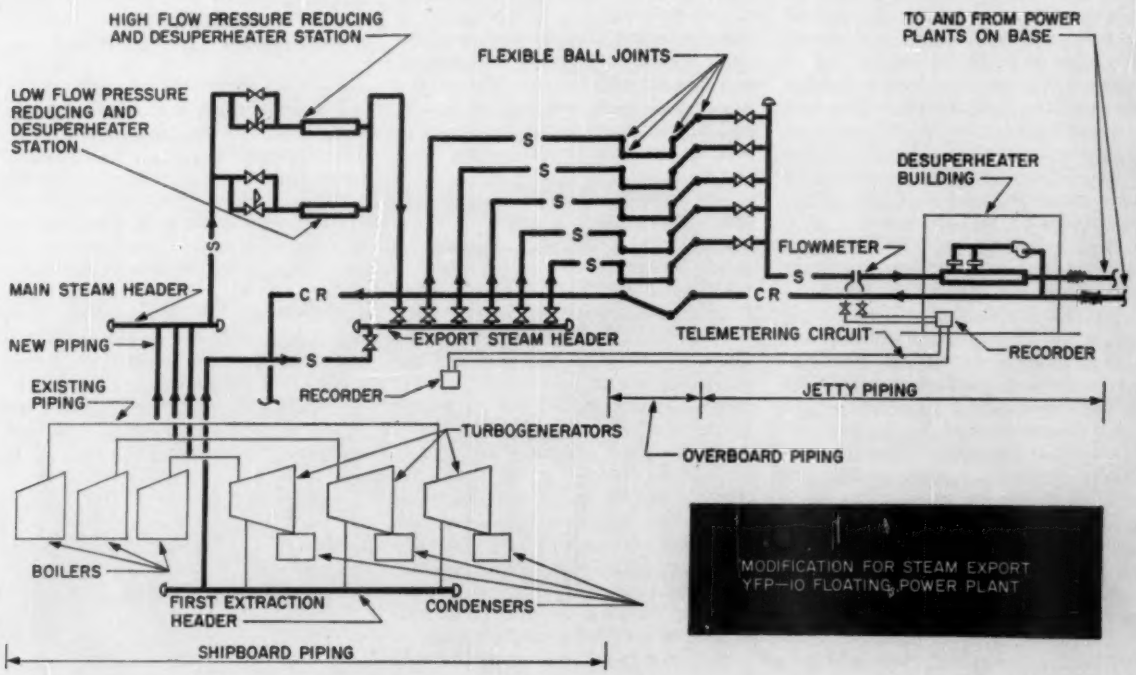
Three turbine-generator units are also included. The turbines are De-Laval 16-stage, impulse-type condensing units. Each has a nominal rating of 12,650 kw at 3600 rpm, and exhaust vacuum of 28.5 in. of mercury. Each turbine has four stages of extraction — for feedwater, oil, evaporator and ship's service heating. Generators are Electric Machinery Mfg Co, rated at 12,500 volts.

Condensers are C. H. Wheeler Mfg Co 8500-sq ft single-pass surface condensers, each requiring 20,600-gpm cooling water at 85 F. This water is provided by one pump (of 21,900 gpm capacity) for each condenser. Each pump is direct-connected to a 150-hp, 495-rpm, 440-volt motor. Suction is taken from a wet-well extending the full width of the ship.

At the port and starboard ends of the wet-well there are openings in the side of the ship for entrance of sea water.

Auxiliary equipment includes two 450-hp, 400-rpm Baldwin diesel engines, each direct-connected to a 250-kw, 480-volt, 3-phase, 60-cycle generator, with belt-connected 125-volt d-c exciter. These generators are connected to the 480-volt auxiliary switchgear and provide power requirements for starting the power plant.

There is one auxiliary Foster Wheeler package-type, oil-fired, water-tube boiler, capacity 2500 lb of steam per hr at 100 psig. This boiler provides steam for space heating, galley operation, fuel oil heating for starting, and other miscellaneous requirements. In addition, there are auxiliary air compressors and air tanks for starting purposes. Fuel storage capacity is 703,540 gallons of boiler fuel, and 9470 gallons of diesel fuel for the auxiliary engines.



Prior to the BMEWS project, Thule Air Base was serviced by twelve individual central heating and power plants, with twelve individual distribution systems, and with limited interconnections. These plants are equipped with a total of 28 Ingersoll-Rand 500-kw diesel units, and 46 boilers of varying sizes. The majority are Orr and Sembower 300-hp units.

The proposed addition of the BMEWS facility involved a considerable increase in base power. Due to the nature of this facility, the major portion of the resulting combined power demand would now be constant and, therefore, the bulk of the required steam supply would also be constant. These conditions pointed to a *centralized* source.

Why Ship Was Used

Use of the YFP-10 would eliminate the immediate need for a conventional facility, permitting postponement to some convenient time in the future. A study of the YFP-10 power and steam systems was made, based on the following considerations:

To be economically feasible, it would be necessary for the ship to supply the power demands of the BMEWS facility, as well as those of the base. In addition, the ship should also be capable of providing a major portion of the steam demand for the base.

Normal power output of the ship, 29,000 kw, was known to be sufficient for the required needs. As for steam, Thule's climate creates a need for year-round steam. This fluctuates considerably, due to the differential in seasonal temperatures — minus 40 F to plus 60 F. Based on the fuel oil consumption required for heating the various base facilities, plus the steam requirements for the buildings under design and anticipated for the future, it was determined that the maximum base steam demand would be in the vicinity of 200,000 lb per hr.

Heat balances on the YFP-10 plant cycle indicated a turbine first-stage extraction capability of 107,000 lb per hr, with the boilers providing 8400 lb per hr of 85-psig export steam and the generators producing combined power needs of the base and BMEWS facility, and better than half of the total steam required for the base.

On those occasions when the base steam demand would exceed the 115,400 lb per hr output of the ship, supplementary steam could be furnished by the existing steam plants on the base, utilizing the plants, or plant, closest to the critical area of low steam pressure.

It was determined that use of the YFP-10 as a centrally located steam and power supply source would realize *an annual saving of $460,000 in fuel costs* over that required by the ten base plants operating independently. The cost of the ship's piping modifications to permit the export of steam was relatively negligible in the light of this saving.

In the schematic sketch of piping modifications, page 77, note the connection between the main steam header and the extraction steam header. This was provided to permit a revision of the heat balance, such that less power and more steam could be produced should some particular set of circumstances arise that would result in additional need for steam.

Proposed use of the YFP-10 as a central power supply would require modification of the steam and electrical distribution systems of the ten existing base plants. However, inasmuch as plans were in existence for the provision of a central power plant on the base, this distribution piping would soon be required in the future. Therefore, it was not considered to be a direct expense contingent with the utilization of the power ship.

Ship Modifications

Winterization features and conversion of the YPF-10 were designed by Reynolds, Smith and Hills, of Jacksonville, Florida. Use of the ship at Thule required complete insulation of the hull, deck, and exposed bulkheads to control condensation and excessive heat loss.

Insulation was applied to the exterior of the ship, beginning at a point 1 ft above the water line. It consists of two layers of 1½ in. polystyrene, impaled on metal studs welded to the hull, secured by nylon fastenings, and covered with layers of glass cloth. Epoxy-base resin was applied to top and bottom surfaces of the polystyrene layers as a finish coating over the glass cloth.

Interior hull insulation begins 2 ft above the water line and extends to the bottom of the ship. Special interior insulation is also provided at tank tops, bulkheads, and specific locations in the overhead.

Primarily, the internal modifications of the ship provided for the export of steam to supply the base steam system. It was also necessary to replace all oil burners and fuel system piping and accessories, and completely clean all fuel tanks. At Thule, only Arctic-grade diesel fuel is used, whereas the original burners were designed for Bunker C fuel. The condenser pump motors were replaced with two-speed 150/25-hp electric motors, enabling the pumps to discharge either 9300 or 21,900 gpm.

Exterior modifications of the ship required the removal of a 30-ton boom and extension of the deckhouse to provide space for the new export steam system, amine water-treatment system, and desuperheater system. Air intake hoods along the deckhouse were also required in conjunction with the replacement of coils to increase the capacity of the boiler combustion-air preheating system.

Modifications for exporting steam included the provision of a main steam header, with individual connections to each boiler and to each turbine lead. With this arrangement, maximum flexibility was provided, permitting operation of any one of the three boilers with any one of the three turbines.

The main steam header is piped to an export steam header via one of two pressure-reducing (and desuperheating) stations, one being for high steam-flow and the other being for low steam-flow. (See p. 77.) Further revision included the addition of a first-extraction header connected to each of the turbines. This is also connected to the export steam header.

All condensate makeup is handled on the ship. In addition to its regular condensate return, the ship requires up to 20 per cent make-up water. Before entering the boilers, the make-up water and condensate are treated.

Surface water supply for Thule Air Base comes from Crescent Lake, located about seven miles east of the berthing site. Hardness of this water is rated at 50 ppm of $CaCO_3$. Study of alternate internal and external water-treatment methods resulted in the selection of two automatic zeolite water softeners with a capacity of 39 gpm each.

Accessories

These softeners are complete with brine regeneration tanks, water meter, multiport valves, piping and controls. The combined capacity of both softeners is greater than the design make-up rate of 72 gpm. The double-unit softener system was selected to provide continuous flow of softened water.

To protect the new on-base condensate lines from corrosion, a filming-amine system is provided. This consists of an amine tank, two reciprocating chemical-feed pumps, an injection nozzle in the steam line, and connecting pipe.

MORE TO COME....

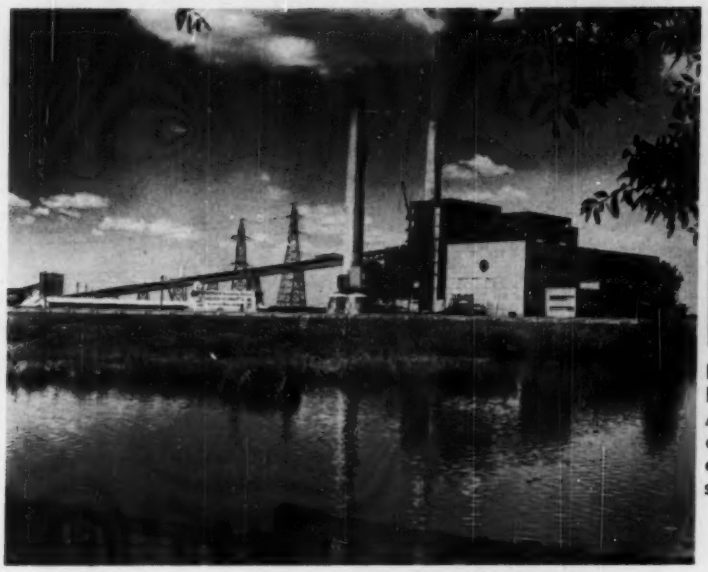


Fig. 1. General view of the Bergen Station
Fig. 2. Pictured at ceremonies are (l to r) A. R. Nelson, general manager, electrical department; E. H. Snyder, vice-president, electrical operation; John Allhusen, station superintendent; R. A. Baker, chief engineer

BERGEN STATION FORMALLY OPENED

ONE OF NATION'S TOP ELECTRIC GENERATING PLANTS

IS OFFICIALLY ADDED TO EASTERN SYSTEM

RECENTLY, Public Service E. and G. Co, of New Jersey, officially dedicated its new 580,000-kw Bergen Station.

In a series of official visits, the plant welcomed public officials, company employees, the technical press, and the general public. While the technical details of this station are generally known, it has some unusual features which are certainly worth talking about.

Members of the technical press were officially welcomed by Mr. E. H. Snyder, vice-president in charge of Electric Operations. Following his talk, Mr. R. A. Baker, chief of Electrical Engineering, highlighted the features of the station design. Then the members of the press were taken on a complete tour of the station. Each editor was given a guide, from the staff of the Public Service E. & G. Co. This was followed by a very nice luncheon.

Reviewing a few of the unusual features in the plant, one of the most outstanding is the fact that the two turbine-generator units, plus their accessories, are laid out so that facilities in one half of the building are practically identical to those in the other half. This tends to simplify layout, save space and cost.

Another unusual feature is the fact that condenser cooling water enters the plant from one stream and discharges into another.

The two generating units are Westinghouse, and each is rated at 290,000-kw, 2350-psi, 1100-F, 3600-rpm cross-compound turbines. There are four generators, each with a nominal rating of 176,000 kva, operating at 3600 rpm and 18,000 volts.

Steam generating units are Foster Wheeler twin-furnace radiant superheater, two-drum, pressurized units. They have a rating of 1,900,000 lb of steam per hour. Both are equipped for dual-firing with coal and gas. Coal is delivered by rail, since the waterways in the area of the plant are not deep enough to afford barge delivery.

Boilers are of the outdoor type, and coal is automatically brought from the storage pile into twelve 70-ton silos above the pulverizers. From there the coal goes through the feeding system into the boiler.

Electric energy from the two generators is stepped up from 18,000 volts to 138 kv and goes out onto the company's transmission line system. The plant was designed by the electrical engineering dept of P.S.E. & G. Co. United Engineers and Constructors were the builders. THE END

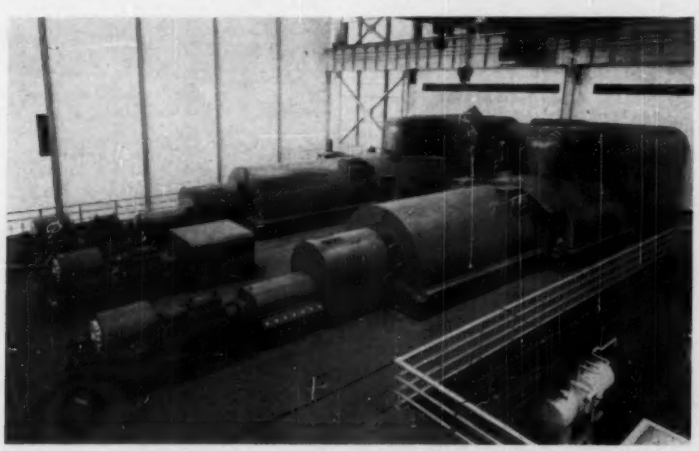


Fig. 3. In-plant view of the two turbine generators plus their accessories

OXYGEN ANALYZER COMPENSATES FUEL-AIR RATIO AUTOMATICALLY

AUTOMATIC OPERATION AT DOW'S MIDLAND PLANT

EXPLAINED BY LESTER FRIEDLE, POWER DEPT SUPT OF CONTROL, AND HAROLD ERBISCH, CONTROL SUPERVISOR

EFFICIENT steam generation requires close control over excess air as boiler loading varies. Any variation in fuel composition greatly complicates the problem of maintaining the proper fuel-air ratio. The obvious answer is to employ an oxygen analyzer and recorder as a guide — and this is quite commonly done. Not so common, however, is the integration of the oxygen analyzer into a combustion control system to provide automatic compensation of the fuel-air ratio. A rather unique installation of such a system at the Midland plant of Dow Chemical Co has proved very effective.

South Power Station houses four 400,000 lb per hr boilers, each of which has two cyclone furnaces. Steam is supplied to two double-extraction non-condensing turbines with throttle conditions of 1250 psi, 830 F. Steam is extracted at 425 and 165 psi, and exhaust is at 25 psi. The generators are nominally rated 30,000 kw when hydrogen-cooled at a pressure of about 15-in. water. Loads of up to 38,000 kw are carried with hydrogen pressures of 3 to 4 psi. If necessary the pressure can be raised to 15 psi.

Boiler feedwater is about 28 to 32 per cent condensate. Remainder is demineralized. Steam temperature control is by means of an attemperator in the boiler drum through which part of the steam is by-passed before entering the secondary superheater.

Combustion control is by means of a Republic system. The station master takes its impulse from the main steam header. Provision is made at a sub-master for biasing one cyclone against the other. The signal then goes to the coal-air ratio relay and then to the coal feed regulator.

Sampling

Each boiler has two Bailey oxygen analyzers. When first installed, water-cooled sampling points were located in the furnace. It was thought necessary to take samples before the convection surfaces to properly control the individual cyclones. However, effective sampling was not obtained at these points because of sampler maintenance problems and slagging conditions. Samples are now withdrawn from points past the superheaters, where sufficient stratification of the gases persists to permit distinction between the two cyclones.

The coal-air ratio relay may be adjusted in two ways: It may be turned by hand, or it may be automatically compensated by the oxygen analyzer. Even though the control switch is closed, for automatic compensation, manual adjustment is still possible. But, in this case, movement by hand will be followed by automatic return to the proper ratio setting. With the control switch open, the recorder continues to show oxygen content of the gases, but there is no automatic compensation of the fuel-air ratio.

With the control switch closed,

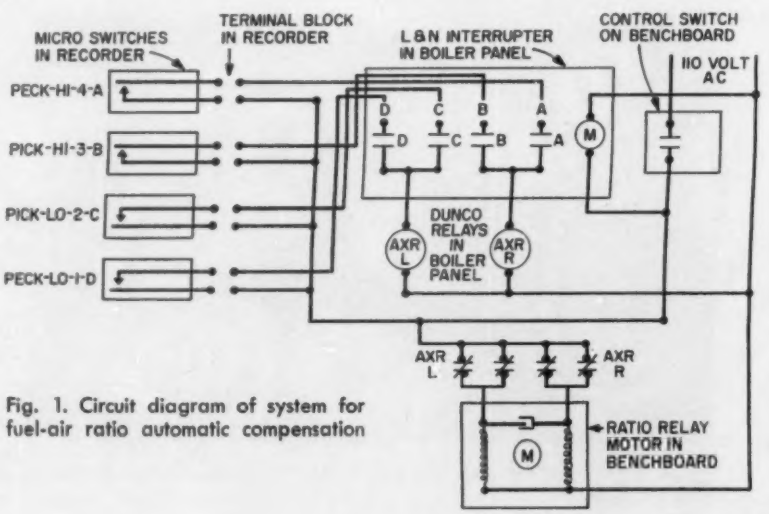
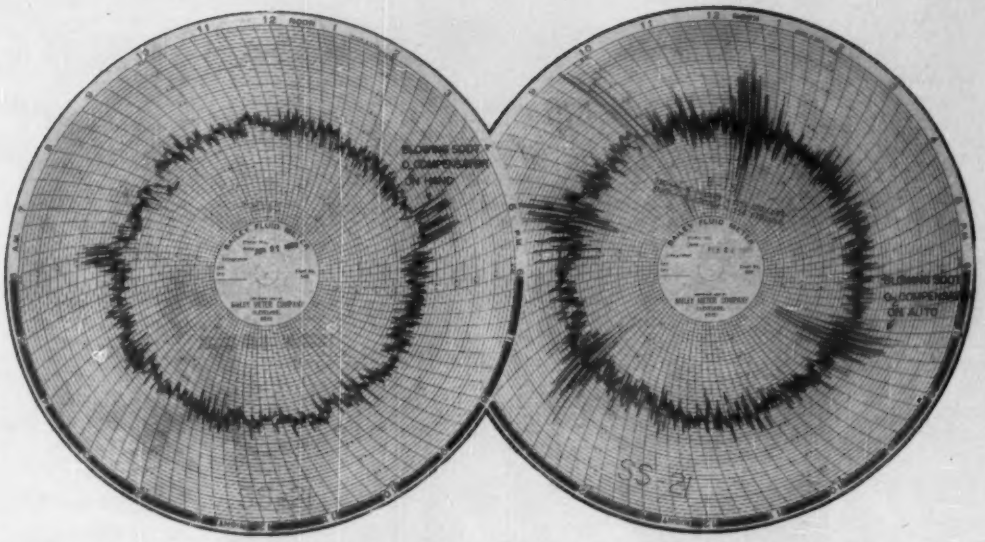


Fig. 1. Circuit diagram of system for fuel-air ratio automatic compensation



Figs. 2 and 3. Oxygen charts show operation while blowing soot with compensation on hand and on automatic

automatic compensation is accomplished by the *pick-and-peck* method developed by Dow engineers. This method utilizes four micro-switches in the oxygen recorder, a four-contact motor-driven interrupter which operates at 5½ rpm, and a split-phase capacitor motor with two equal windings.

Operation is set for a mean value of 2.5 per cent oxygen. As long as the content is between 2.25 and 2.75 per cent, all four micro-switches remain open. The four switches are labeled *pick-lo*, *pick-hi*, *peck-lo*, and *peck-hi*. If oxygen content rises to 2.75 or drops to 2.25 per cent, the *pick-hi* or *pick-lo* switch, respectively, will close. Should the oxygen content continue to rise or fall, then the *peck-hi* or *peck-lo* switch will close at 3 or 2 per cent, respectively. When the trend in oxygen content reverses and tends back toward the mean value, the switches open in reverse sequence at the same values at which they closed.

Each micro-switch is connected between one side of a 110-volt a-c line and one contact of the interrupter. The other side of the a-c line connects through two relays to the other interrupter contacts connected in pairs: one pair for the two *hi* switches, and one pair for *lo*. (See Fig 1.)

Automatic Compensation

The two fields of the split-phase motor are connected across the line with a relay-operated switch in series with each winding. Both relay-operated switches are normally closed, so that the motor is always fully excited but in a stalled condition. This situation persists as long as oxygen content is within the middle range, and all four micro-switches are open.

When a micro-switch closes, the relay with which it is associated opens the circuit to one field winding of the split-phase motor. This permits the motor to operate and to change the setting of the fuel-air ratio relay. Thus automatic compensation is accomplished.

The interrupter contacts are adjusted for 0.07 sec closure of *pick* contacts and 0.15 sec closure of *peck* contacts during each revolution. At approximately 5½ rpm of interrupter cam shaft, closure of a *pick* micro-switch causes the ratio-relay motor to operate 0.35 sec per minute, while closure of a *peck* switch causes 0.75 sec of operation per minute. Adjustment of the ratio relay is thus a very gradual process, and surges are not initiated by the control equipment.

Oxygen charts, Figs. 2 and 3, show operating conditions on two typical days. One chart shows oxygen content when soot-blowing was done with the control switch set for automatic compensation; the other chart shows the better results achieved by opening the control switch while blowing soot.

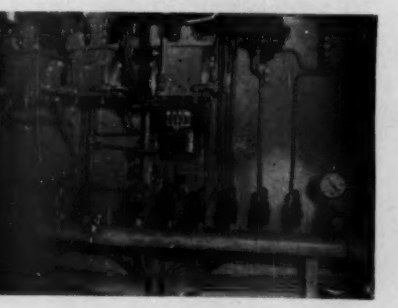
The photographs, Figs. 4, 5 and 6, show a general view of the panel, the location of contacts in the interrupter, and the location of the split-phase motor directly below the ratio relay, under the bench board.

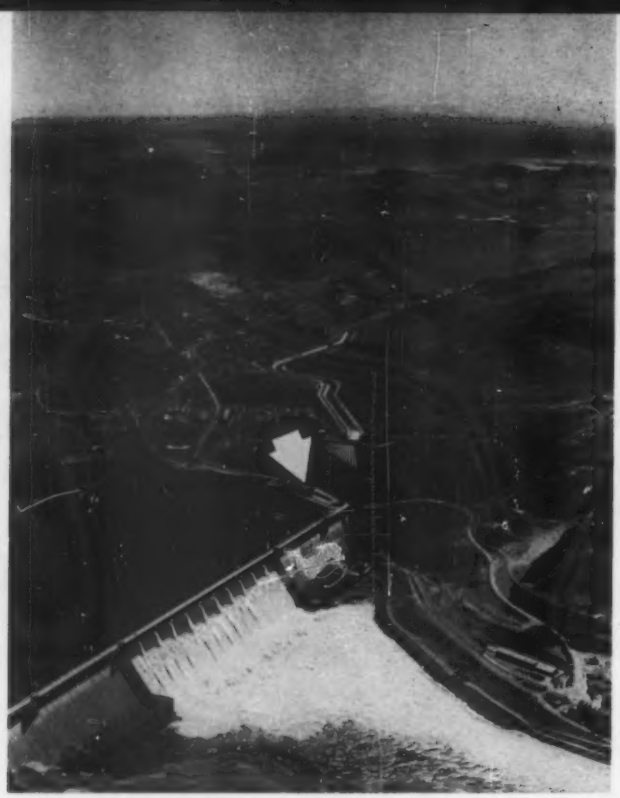
This system has proved to be dependable and effective, and no significant maintenance problems have been introduced. A similar system is at present being installed for a fifth boiler. THE END

Fig. 4. General view of control panel

Fig. 5. Interrupter motor and contacts

Fig. 6. Ratio relay motor in benchboard





GRAND COULEE PUMPING PLANT OPERATION AND MAINTENANCE

ELECTRICAL ENGINEER GLENN BARKER DESCRIBES

OPERATION OF ONE OF THE WONDERS OF THE MODERN WORLD

GRAND COULEE DAM is recognized the world over as one of the greatest engineering feats in modern times and as one of the largest producers of electrical energy.

Built primarily to raise the water level of the Columbia River about 340 feet, the dam was constructed by the Bureau of Reclamation as part of its Columbia Basin Project in the State of Washington, and power is actually a secondary product. Large single-stage vertical-shaft pumps driven by 65,000-hp synchronous electric motors lift the water another 280 feet into a prehistoric channel of the Columbia River. This channel, called "The Grand Coulee," is now used as part of the water storage and distribution system for this irrigation project.

Located directly behind the west abutment of Grand Coulee Dam (see arrow on picture), the pumping plant was designed to accommodate a total of 12 pumps, each capable of supplying the water required to irrigate 100,000 acres of land. When the 1,029,000 irrigable acres of the project are all under cultivation, ten pumps will be required to supply the irrigation water, and the remaining two pumps will be on stand-by.

First pump went into operation in May 1951, and by the start of the project's first official irrigation season in 1952, six pumps were ready for operation. Each pump lifts from 1200 to 1600 cubic feet of water per second up the 280-ft vertical distance through about 800 feet of 12-ft-diam steel pipe. From this point, the water discharges into a feeder canal which flows into Banks Lake, an equalizing reservoir with a capacity of one million acre-feet of active storage.

Pumps are generally operated only during the irrigation season, which includes the months of April through August. In ten operating seasons, these pumps have been operated for a combined total of more than 93,000 hours. Over 3¾ trillion gallons of water have been pumped from the Columbia River for use in irrigating the farms of the Columbia Basin Project. As a comparison, this amount of water would cover an area the size of New York City (315 sq miles) to a depth of more than 57 feet, or 9 feet of water over the entire area of the State of Delaware.

Operation of the pumps is primarily regulated by the demand for irrigation water. At the start of the season, in April, the irrigation water required is drawn from Banks Lake. The pumps are started when the best pumping conditions exist; i.e., the elevation of Franklin D. Roosevelt Lake behind Grand Coulee Dam is at its maximum elevation, and off-peak power is available for pumping, or when the stored water in Banks Lake is near depletion.

When the pumps are started, usually all of them are operated continuously until Banks Lake is refilled. Then, as required to keep Banks Lake filled and to supply the irrigation water demand, two or more pumps are on continuous operation; the remaining units are operated during off-peak power demand periods.

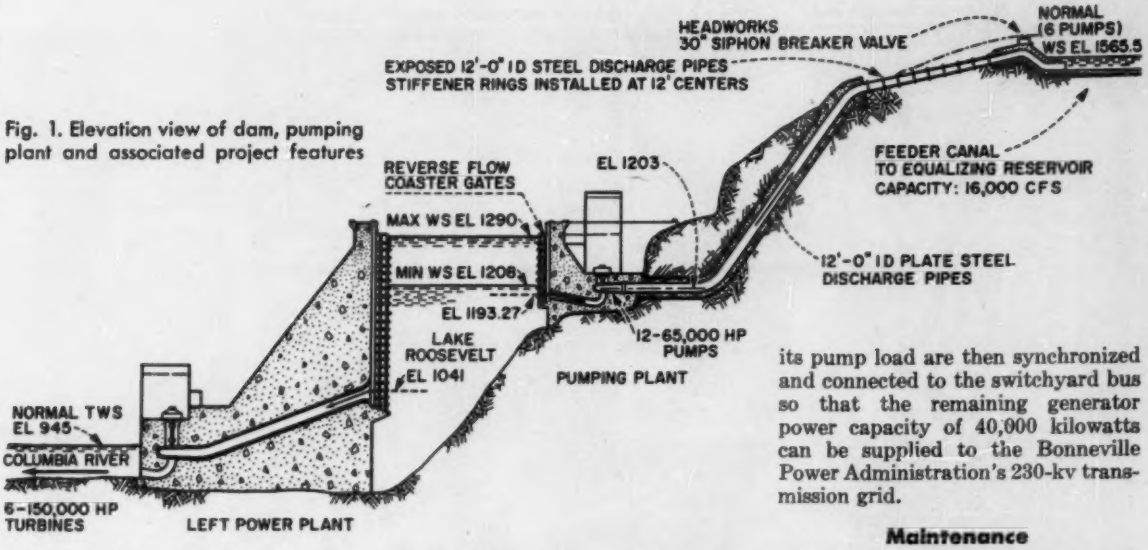


Fig. 1. Elevation view of dam, pumping plant and associated project features

Intermittent operation of these 65,000-hp synchronous electric motors would generally imply increased costs for maintaining the starting equipment and the associated auxiliaries. This is not the case in this operation since a reduced-speed, induction-start method is used. A single line diagram of the 13.8-kv isolated phase bus system for one 108,000-kw generator and its two associated pumps is shown in Fig. 3.

Induction Start

For an induction start, the generator is removed from the bus by opening the generator oil circuit-breaker in the 230-kv switchyard. The generator speed is then reduced to one-half normal or 60 rpm. The generator main exciter field breaker is opened and the excitation rheostat set to a position which will give the desired generator field excitation when the generator exciter breaker is closed in the pump starting sequence.

An excitation current of 1100 amperes at 250 volts is used when only one pump is started, and approximately 1600 amp when both pumps are started simultaneously. With the generator main exciter rheostat set for the desired field current, the powerhouse operator at the generator control panel closes by remote control first the pump motor air circuit breaker, and then the generator main exciter field breaker. Approximately 500 amp starting current is supplied to the motor from the time the air circuit breaker closes until the generator main exciter field breaker is closed.

When the main exciter breaker is closed, the starting current gradually increases and attains a maximum of 4000 amp in 23 to 25 sec as the motor is accelerated as an induction motor. During this time the speed of the generator decreases from 60 to 30 rpm because of the electrical load of starting the pumps.

If the speed of the generator drops below 30 rpm, the powerhouse operator manually adjusts the governor speed controls to bring the generator speed back to a 30-rpm minimum operating speed. Synchronism between generator and pump motor is usually accomplished in 30 to 35 sec. The pump motor field breaker is then automatically closed by the field application control circuits.

With the generator and pump motors in synchronism, the generator turbine gates are gradually opened, and normal operating speed is attained in approximately one and one-half minutes. The generator and its pump load are then synchronized and connected to the switchyard bus so that the remaining generator power capacity of 40,000 kilowatts can be supplied to the Bonneville Power Administration's 230-kv transmission grid.

Maintenance

Each year the motor-pump units are given a maintenance check which includes inspection of the thrust bearing, readjusting guide bearing clearances, inspection of the pump packing, testing the motor winding insulation resistance by the high voltage d-c method, and inspection of the pump impeller. Generally, this annual maintenance can be completed in 5 eight-hour shifts.

Major maintenance item to date has been in the repair of the cavitated areas on the pump impeller. After the first three operating seasons, with the total operation time amounting to 5500–6000 hours per unit, about 15 to 20 per cent of the area of the cast steel pump impeller blades was cavitated and in need of immediate repair. The cavitated area can be described as a rabbit ear configuration with one oblong area on the face of one impeller blade and another on the back side of the leading blade (Figure 2).

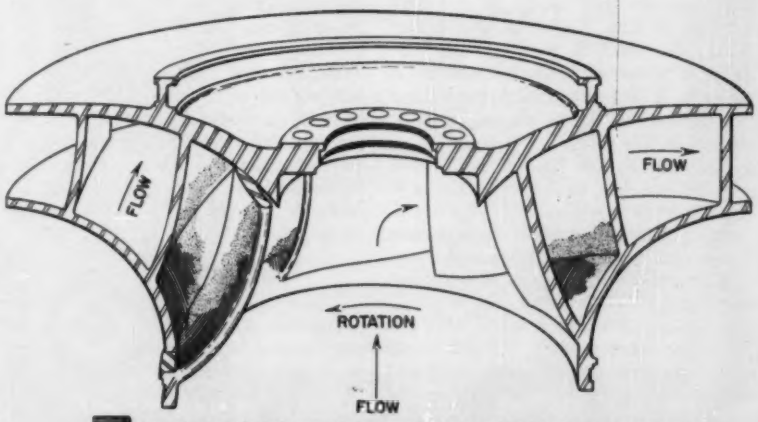


Fig. 2. Pump impeller sectional view, showing areas affected by cavitation

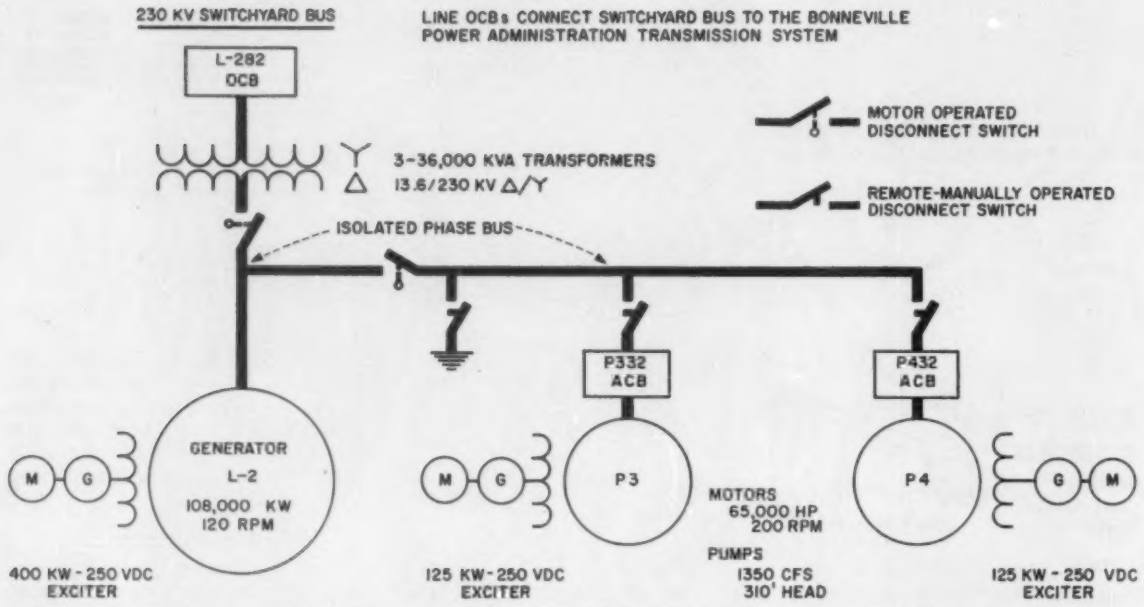


Fig. 3. Single line diagram of 13.8-kv isolated phase bus system for the 108,000-kw generator and its two associated pumps

The most serious cavitation appeared in the trough between the blades where the two oblong areas joined together. This area was cavitated to a depth of 5/16 to 3/8 in. in the three operating seasons. Cavitated depths as much as 3/4 and 1 in. were also found on several of the blades. These heavily cavitated areas were probably the result of a sand hole or flaw in the original casting of the impeller since there was no similarity in the location pattern.

Impeller Repair

In repairing the impellers, the cavitated area is burned out by the electric arc-air method until all cavitated metal is removed and a good surface is obtained on the parent metal. The opposite side of the blade is sprayed with water during this operation so that warping and distortion of the blade is negligible. After the area is burned out, one layer of arc-welded stainless steel is applied. A 25 per cent chrome–12 per cent nickel stainless steel rod (E-309) is used in this initial layer to secure a good bond to the parent metal and to stabilize the carbon in the cast steel impeller.

With this initial layer acting as a bond and a barrier to any further dilution of the stainless steel with the cast steel of the impeller, the remaining layers of weld are made with 18 per cent chrome and 8 per cent nickel stainless steel rod (E-308), which has proved to be very satisfactory in resisting cavitation. Generally two layers of weld with the E-308 rod are sufficient, but as many as four and five have been used in the deeply cavitated areas. After the welding is completed, grinders are used to grind the welded areas to a smooth surface that is essentially the same as the original design contour.

To date, it has been possible to repair the cavitated areas without removing the impellers from the pump. Work procedures and methods required because of limited space available for men and tools make this a slow, time-consuming repair operation. The average time required for the initial repair of one pump impeller is 15 man-days to burn out the cavitated metal areas, 125 man-days for welding, and 55 man-days for grinding.

Stainless steel of the repaired areas appears to be in its original condition even after five and six operating seasons. Cavitation of the cast steel impeller has continued in the area beyond the initial repaired areas and extended the rabbit ear pattern further out on the vanes. These areas have been repaired as required in the past six years since the initial repairs were completed. Ultimately, all areas of the impeller affected by cavitation will be covered with the stainless steel weld.

Modifications

Other operation and maintenance problems of a minor nature were experienced in the initial testing and early operation of the plant. Some of the problems were solved by changing the operating procedures, while others required modifications to the existing facilities or the installation of additional equipment. One of these problems concerned the turbulence of the water and the large fluctuations in pressure inside the pump casing.

What Tests Showed

Tests indicated the pressure differential on opposite sides of a splitter in the pump casing was as much as 25 psi, and the splitter was vibrating excessively during pumping operations. Through a series of tests, it was shown that the vibration and turbulence could be greatly decreased by removing most of the casing splitter and modifying the leading edge of the pump casing diffuser vanes. These changes in the pump casing increased the over-all capacity of the pump while decreasing the water turbulence and vibration in the pump and the discharge line.

Pump capacity was also increased by squaring the outer edges of the impeller vanes normal to the vane instead of the circumferential line as designed. Efficiency tests, using the salt velocity method, indicated the modified pumps were 91.3 per cent efficient when delivering 1300 cfs at 337-ft head and 86.9 per cent when pumping 1600 cfs at 285-ft head.

Operation of the pumping plant has been very satisfactory, and only minor changes are planned in the design and installation contracts for the remaining six pump units. These pump units will be installed, when required, to meet the irrigation water demands of this project as its development continues to its ultimate size of 1,029,000 acres. THE END

For General Electric Company, Stone & Webster constructs

Towers to touch TOMORROW

Near Pittsfield, Mass., Stone & Webster Engineering Corporation has helped design and is supervising construction of General Electric's vital PROJECT EHV (Extra High Voltage). Here, in a 4.3 mile "outdoor laboratory", G. E. and Western Massachusetts Electric Company will test power transmission at voltages from 380-to 750-kv — higher than any transmission system in operation in the world. Variety of towers includes the huge portal type(above). EHV is a giant step toward the economical solution to man's ever-increasing demands for electricity.

Stone & Webster has played a key role in the development of electric power... from the earliest hydro projects to the successful production of peaceful atomic power. From this deepening reserve of experience and special skills, Stone & Webster engineers can bring extra efficiency and economy to any type of power project. For complete information please call or write our nearest office.

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HANDBOOK

Power Engineering

New Compressor Liner Extractor

AN EXTRACTOR for air compressor liners has been devised by Terry McDonald of the Philadelphia Naval Shipyard. As reported in the Bureau of Ship's *Journal:*

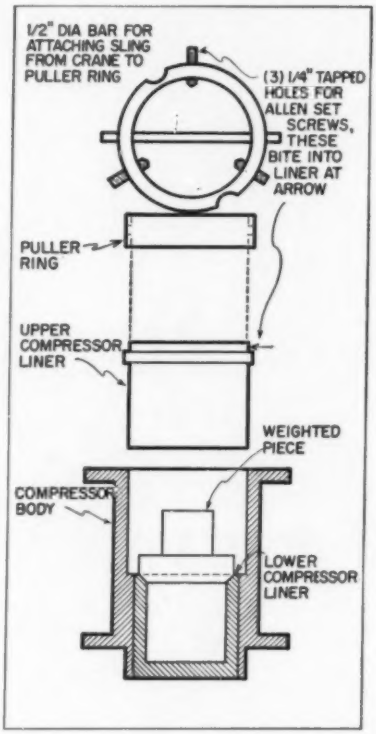
Formerly, oblique holes were drilled in the upper portion of the upper liner with much difficulty. Half-inch diameter pegs were placed in the holes, and a gear puller was used to extract the liners individually. The lower liners were removed by application of heat and use of an hydraulic press. Three men were needed for the job. The liners were ruined, and the pegs often pulled out.

The new extractor is shown in the sketch. The brass puller ring is placed over the periphery of the upper liner. In this ring, 120 deg apart, are three ¼-in. tapped holes for Allen set screws. These pointed screws anchor the ring to the liner. Also in the ring, at a point above the face of the liner, are two diametrically opposite holes. These holes can house either a ½-in. diameter bar or eyebolts.

A wire sling is passed through the eyebolts or around the ½-in. bar at the outside of ring to prevent the sling from shifting. The other end of the sling is attached to a crane or a block and fall. A weighted piece is then placed on the angular face of the lower cylinder as shown in the sketch.

The whole assembly is lifted off the floor far enough to allow the lower assembly to fall free. In some cases, a series of blows will suffice. Usually, heat is applied to expand the cylinder housing. First the lower liner supporting the weighted piece falls, and then the compressor falls away from the upper liner. The job can be done by one man.

The rings and plates are universal. Once made, they can be used on all liners, and they are practically indestructible. If the old liners ever have to be reinstalled, they are in the same condition as before removal. This was not possible with the old method because holes were drilled in the liners.


1/2" DIA BAR FOR ATTACHING SLING FROM CRANE TO PULLER RING
(3) 1/4" TAPPED HOLES FOR ALLEN SET SCREWS, THESE BITE INTO LINER AT ARROW
PULLER RING
UPPER COMPRESSOR LINER
WEIGHTED PIECE
COMPRESSOR BODY
LOWER COMPRESSOR LINER

Making Test Leads More Handy

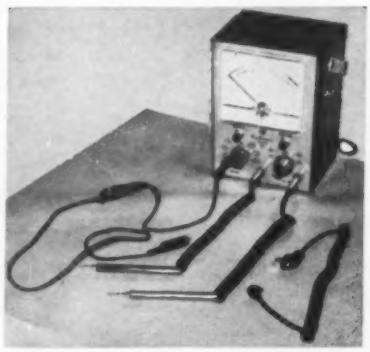
By HARRY J. MILLER

CONVENTIONAL test leads used with plant test meters are so long they often foul up with tools and components on the test bench.

We avoid this trouble by replacing the leads with the coiled leads common to cameras. These leads have two wires in them which are soldered into the plug and test probe to make a single wire having longer-assured continuity.

In use, these coiled wires are pulled out to the task at hand. When let go, they coil back up into a minimum of space.

When the coils lose their spring, this can quickly be restored simply by re-winding the coils in the opposite direction.



At left in the photo is shown the conventional lead; in the center is a pair of the short leads converted from the camera cords similar to the one shown at right.

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Sludge in engine ends with switch to STANODIESEL Oil M

Situation: For five years a 1,400 hp. engine in the Municipal Light Plant, Arcadia, Wisconsin, was operated on STANODIESEL Oil M. During this time the engine ran free and clean. It carried a major share of the plant's 20,000 kw. output. A decision was made to switch the engine to another lubricant since it was believed one oil was as good as another.

What happened: Within two years the engine had sludged up so much, the oil had to be removed and replaced by STANODIESEL Oil M. Three months later the engine had cleaned up and was again carrying its share of the plant's load.

Clean engine operation is possible with STANODIESEL Oil M because of its superior base stock and its combination of additives that are available in no other oil. Superior base stock and exclusive additives give you these cost-saving operating and maintenance advantages: less sludging, low oil consumption, reduced port deposits, fewer stuck rings, less need for ring replacements, less cylinder wear, lower filtration costs, fewer bearing problems.

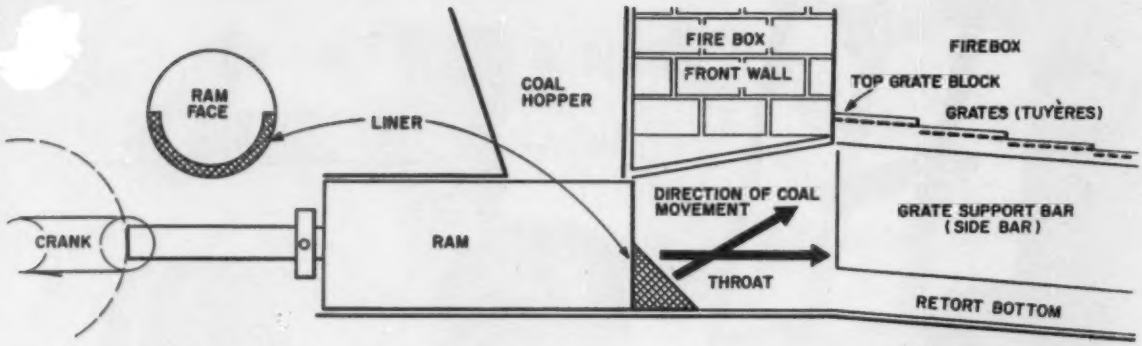
Get more facts about STANODIESEL Oil M. Call the Standard Oil office near you in any of the 15 Midwest or Rocky Mountain states. Or write **Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.**

You expect more from **STANDARD** *and you get it!*

The team that got the engine back in shape: (l. to r.) Vernon Schwertel, Ronald Darbo and Standard's Fred Parkinson. Providing lubrication technical service on problems like this one is not new to Fred Parkinson. He's been doing it for 11 years. He has further qualification for such work—an engineering degree from Brown University. Fred has also completed the Standard Oil Sales Engineering School.

Quick facts about STANODIESEL Oil M

- Keeps crankcase, pistons, cylinder walls clean.
- Combats deposit and wear problems imposed by economy fuels.
- Maintains film on difficult-to-lubricate parts.
- Eliminates fuel injector and pump sticking caused by deposits on injector barrel and plunger where fuel and lube oil mix.



How We Improved the Handling of Fines

By HERMAN A. LUDEWIG, Principal Sta. Engineer, Green Haven State Prison, Stormville, N. Y.

FINES in the standard underfeed stoker can be a great source of trouble. Not so much in burning them (indeed they are quite useful in building a firebed) as in getting them into the firebox. Moving fines is troublesome and dirty; siftings losses are greatly increased.

The more solid firebed incurs a greater draft loss through it and, quite likely, requires the use of wet fuel to render the fuel bed more porous, at some efficiency loss, however. More fuel bed agitation is required when a large percentage of fines is present, rendering the bed thinner. Thin beds must be watched to prevent holes and blow-torch action. As the toes burn off the grates, control over the firebed contour becomes increasingly difficult. Human nature, being what it is, cannot be relied upon to furnish and sustain the necessary continued vigilance.

Our greatest difficulty with fines was that the rams would not push them far enough into the retort to prevent a jam in the throat. The throat is that space enclosed by the chute-sides, bottom and top. (See figure.)

Although the planes of the chute sides diverge towards the fire, enormous pressures are created in the throat, causing rapid wear of the sides and bottoms and early failure, not to mention frequent breakage of safety pins and even crank bearings. Since with fines, a greater amount of coal is delivered than with coarser coal, per stroke, the situation is aggravated.

There are several ways to give relief. The best way is to buy longer rams. This might not bring 100 per cent cure and is expensive. Also, increased stoker speed becomes necessary since less coal is delivered per stroke; greater wear of liners in the cylinders takes place due to the greater weight of the rams and their longer linear travel per hour.

Liners, to be bolted to the end-surface of the rams, are available. They have the benefits and drawbacks of the longer ram, in a slightly decreased percentage.

Our solution eventually turned out to be the use of a longer type of ram. We also used liners, although only half a liner was used per ram, installed as shown in the sketch. The liners were split in half, and one half was welded to the bottom of the pushing face of the ram. An inward and upward force is then exerted on the coal, far enough into the throat to ameliorate the congestion.

A further benefit is that the vulnerable top-grates have a better chance of remaining covered. Their loss usually starts off a chain-action of grate burning. Once the top-grate is lost, the burning coal enters the side-bar, heating the tuyères from underneath and shutting off the air stream so necessary to keep them cool. One after another the grates melt and expose their next lower neighbor to destruction. The side-bars themselves will also suffer extensive damage (they cost us $235 apiece).

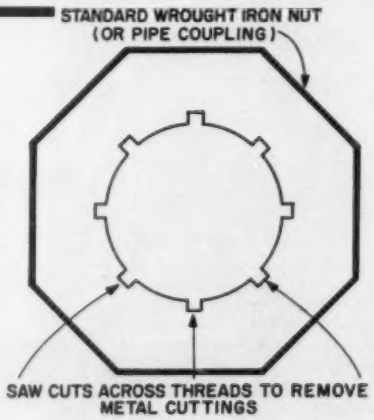
Since we are burning sized coal, we removed coal-agitators from all coal hoppers. These power-hungry and sometimes troublesome appliances were a "must" formerly, as was also frequent manual coal agitation in coal-lorry and chutes.

Simple Way to Make Threading Die

By B. W. HAUSMAN, Engineering Dept, Dominion Glass Ltd., Wallaceburg, Ontario, Canada

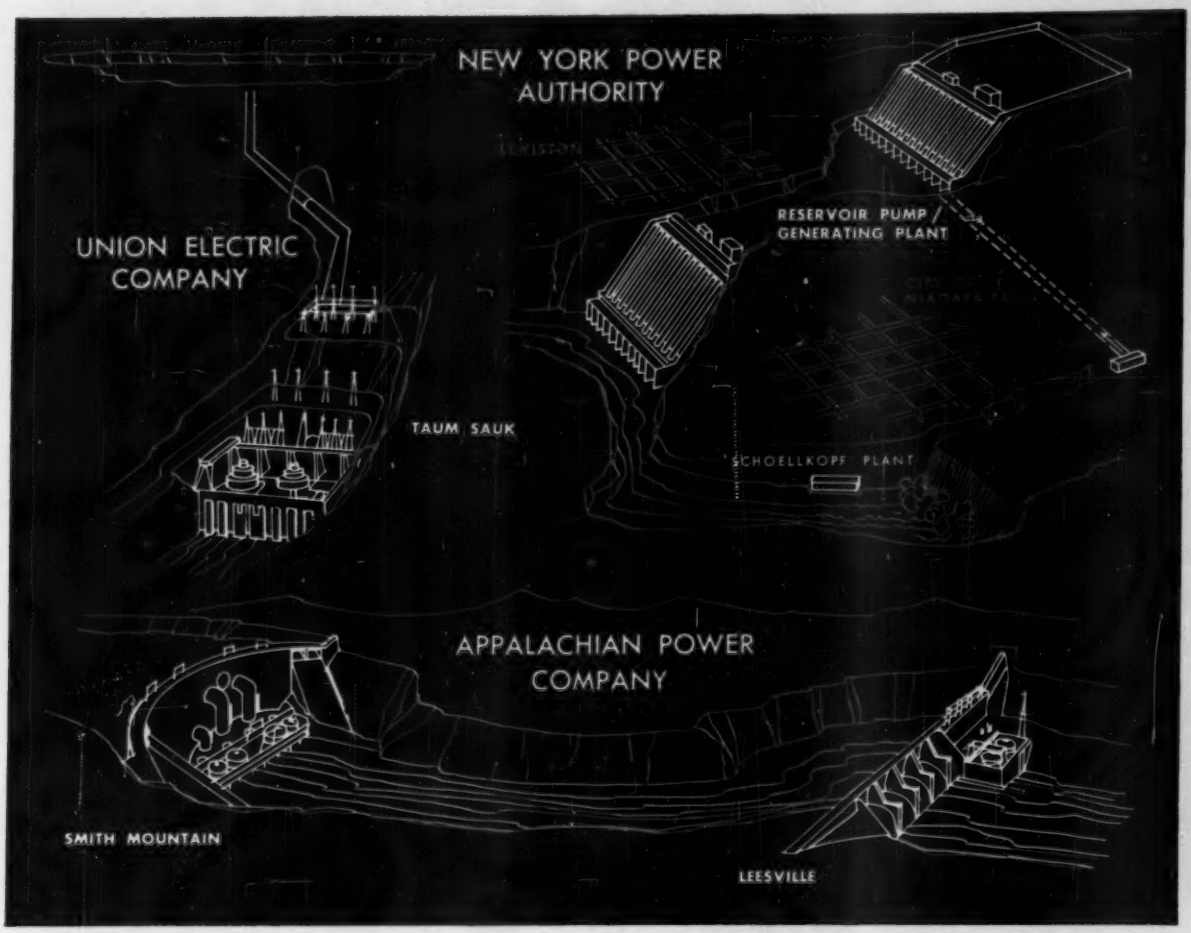
VERY OFTEN, not having the necessary die, or in difficult places, one has to rethread or prolong battered, bruised or just too short threads, particularly on pipe ends.

A simple way out is to take a wrought iron nut or pipe coupling having the same thread, and cut several radial grooves in it with a file or hand saw. Then, after heating the nut to a dull red color, sprinkle the thread several times with granulated sugar, until it burns. This produces a thin, very hard (case) surface. Threading die produced in this manner gives very good results.



Power Engineering HANDBOOK

ALLIS-CHALMERS



Just what you'd expect from the pumped-storage pioneer:

first in all three

Pumped-storage power projects now under construction in this country all rely on Allis-Chalmers reversible pump-turbines. In fact, A-C is the only builder of complete reversible pump-turbine equipment!

First in boosting existing hydro at Niagara Reservoir pump/generating plant! This pumped-storage project will capitalize on the hydro-electric power potential of Niagara River without adversely affecting the scenic beauty of the Falls. Largest project of its kind, this installation will include 12 reversible pump-turbines with motor-generators . . . all designed and fabricated by Allis-Chalmers. As a turbine, each unit is rated 28,000 hp under 75-ft net head; as a pump, 3,400 cfs at 85-ft total head.

First in pure regeneration — at Taum Sauk! . . . also to have the largest-capacity hydro units ever built. Allis-Chalmers will supply two 175,000 kw reversible pump-turbines, each with a capability exceeding 300,000 hp under 800-ft head. (Pure regeneration installations need only a water supply to replace evaporative losses, so a creek is ample. Even a hill is unnecessary: the pool can be underground, in an abandoned mine shaft, for example.)

First in run-of-river — at Smith Mountain! This new project involves reservoirs at two successive levels, the lower dam forming a tailrace pool at the upper dam for two A-C reversible pump-turbines, each rated 87,000 hp at 180-ft head. Conventional hydro-generating units will also be installed — two higher-head units at the upper dam and two lower-head units at the lower dam.

For complete information on pumped-storage, hydro-generating equipment or other components for water control, contact your nearby A-C office. Or write to **Allis-Chalmers,** *Hydraulic Division, York, Pa.* A-1385

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CONSTRUCTION NEWS

Window Rock, Ariz. — Arizona Public Service Co, Phoenix, Ariz., and Utah Construction & Mining Co, San Francisco, Calif., have received approval from the Department of Interior of an agreement between the Navajo Tribal Council and the two companies for the construction and operation of a 350,000-kw steam electric generating plant on the Indian reservation, near Fruitland, N. M. The $100,000,000 facility will be built on 1250 leased acres, and fuel for the plant's operation will be mined and furnished from 24,000 acres of undeveloped tribal lands also leased by the Utah Construction & Mining Co. Work on the project has begun and is scheduled for completion by the spring of 1964.

Eureka, Calif. — Pacific Gas & Electric Co, 245 Market St, San Francisco, Calif., has authorized plans and work will begin soon on a 50,000-kw boiling-water reactor at a company location at Humboldt Bay, near Eureka. No objections were raised in a recent meeting held in Washington, D. C., to the safety design of the proposed plant. At issue is a new type of containment design, called "pressure suppression." General Electric Co and the utility propose to replace a high-cost, thick-metal containment shell design to handle any accident involving escaping steam for the reactor's system. New design would quench escaping steam in built-in water pools, which would be much less expensive to build than the containment shells.

Los Angeles, Calif. — The Ramo-Woolridge Corp, 8820 Bellanca Ave, this city, division of Thompson Products, Inc, Cleveland, O., has announced the development of a compact fuel cell which regenerates its own fuel. A typical unit, designed to generate 500 watts of power for 60 days, will weigh only 200 lb, or one-sixth the weight of a non-regenerative system and the additional fuel it would require. This estimate includes the weight of the heat source, probably a small nuclear reactor, required to regenerate the fuel. The system can be designed to produce between

Valve Manual Reprints

Recently out of print, the Power Engineers' Valve Manual is being reprinted as a result of numerous requests for copies. The Manual is a collection of eight articles which appeared in POWER ENGINEERING and were written by experts in the field.

Power Engineers' Valve Manual covers the basic types of valves. Although there are hundreds of different styles, all are modifications of the types covered in the Manual.

To obtain a free copy write the Editor, POWER ENGINEERING, 308 E. James St, Barrington, Ill. Quantity lot prices will be quoted on request.

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Here is the biggest "CARE package" the people of America ever sent to desperately poor people of other lands: A mobile health unit which brings medical care to four villages in India. It heals the sick. It teaches simple hygiene. It helps people find strength enough to lift themselves by their own bootstraps.

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The unit above is sponsored by the Bombay Mothers' and Children's Welfare Society and staffed by a native medical team—doctor, nurse, technician, driver-helper. Diagnosis ... treatment ... surgery ... preventive medicine—all are part of the job.

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New fuel cut-out control by Reliance

Pipe one device for double protection

and add alarm for approaching low water level if desired...

Reliance Levalarm EA-100P

Using but one water chamber — one set of pipes to boiler — this new Reliance Fuel Cut-out and Alarm control gives you two efficient devices in one.

At one end (right hand above) a positive float-operated switch cut-out; at the opposite end, an electrode-type control using U.L.-approved transformer-relay hook-up — completely independent of the float-type control but employs a common water chamber.

Check these possible use-combinations of the Levalarm EA-100P:

1. Dual fuel cut-out control.
2. Float-operated fuel cut-out and electrode-operated low water level alarm.
3. Electrode-operated fuel cut-out and float-operated low water alarm.
4. Float-operated fuel cut-out and electrode-operated fuel cut-out and electrode-operated low water alarm.

This Levalarm is the convenient answer in cases where two independent fuel cut-outs are required.

And this Levalarm provides outstanding additional safety to the operation of factory assembled boilers.

Write today for full description of this new safety device.

The Reliance Gauge Column Company • 5902 Carnegie Avenue • Cleveland 3, Ohio

Reliance BOILER SAFETY DEVICES

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200 and 1000 watts of electricity for periods ranging from 60 days to a year. Since it reuses a small amount of fuel, it becomes more practical for longer operating periods.

Torrance, Calif. — Harvey Aluminum, Inc, 19200 South Western Ave, has announced the signing of a power contract with the Bonneville Power Administration, a Federal power marketing agency, for a proposed aluminum-making plant expansion in the Northwest. BPA has agreed that it will provide 150,000 kilowatts of power to Harvey for a proposed new two-pot line aluminum reduction plant. Proposed plant would have a capacity of approximately 75,000 tons a year of pig aluminum, which would just about double the company's present capacity. Harvey has until July 1961 to select the site and designate points of delivery for the power, which are scheduled to begin not later than December 31, 1963. Failure to meet either deadline may result in contract rights being terminated.

Atlanta, Ga. — Board of Regents, University of Georgia System, 244 Washington St, S.W., has authorized plans for the construction of a new nuclear reactor building on the campus of the Georgia School of Technology, located here. Contract award in the amount of $3,076,500 has been awarded to the Blount Bros. Construction Co, Montgomery, Ala., for the work which will begin at once and will be completed by the spring of 1962.

Chicago, Ill. — Commonwealth Edison Co, 72 W. Adams St, this city, has announced that the cost of electricity produced at its Dresden nuclear power station will be about the cost of power generated at plants using conventional fuel. The 180,000-kw plant, built at a cost in excess of $51,000,000, is the world's largest operating nuclear power station and the first to be built through private financing. Construction of the facility began in March 1957, and was recently completed four months ahead of the target date. Based on the $36,000,000 capitalized by the company, the Dresden facility will eventually produce electricity at a cost of about 7.5 mills per kilowatt hour, which is approximately the cost of electricity produced in 1955.

Marion, Ill. — Southern Illinois Coöperative, Inc, Dongola, Ill., has announced contract award to Allis-Chalmers Manufacturing Co, 1126 S. 70th St, Milwaukee, Wis., for three 33,000-kw turbine generator units in conjunction with the construction of the company's 99,000-kw power plant to be located on the south fork of the Saline River, near here. Plant, now under construction at a reported cost in excess of $21,000,000, is targeted for completion late in 1962. Burns & McDonnell Engineering Co, Kansas City, Mo., is the project engineer.

Bow, N. H. — Public Service Company of New Hampshire, 1087 Elm St, Manchester, N. H., has announced that it has placed in line a new 110,000-kw steam electric generating unit at its power plant located here. Plant, completed this fall at a cost estimated at $22,000,000, will bring total steam generating capacity to over 370,000 kilowatts. In addition, utility has some 74,000 kw of hydro-generating capacity, which has been a declining factor in the company's over-all generating capacity in recent years. Company has announced that capital expenditures this year would run about $17,500,000, about the same as in 1959.

more items on page 94

How Much Steam Should a Steam Trap Trap?

. . . some answers to commonly asked questions about the primary job of a steam trap

You don't need a doctor's degree in thermodynamics to answer the question at the top of this page. Naturally, a steam trap should trap *all* the steam.

Unfortunately for you, the problem isn't quite that simple. After all, a shut off valve would trap all the steam . . . and condensate, and air, and carbon dioxide as well.

So we'd better amend the answer to the question this way: A steam trap should trap *all* the steam but *must* remove condensate, air and carbon dioxide as rapidly as they accumulate.

With this established, let's take a closer look at what's involved:

A Steam Trap Should Trap All The Steam

If you've had experience with several different makes of traps, you already know that some trap steam better than others. The operating principle of the trap is what makes the difference. We like to talk about it because Armstrong traps are designed so that no steam can get to the orifice. The valve is always water sealed. Result: *More efficient steam utilization, lower fuel costs.*

A Steam Trap Should Remove Condensate

All traps remove condensate—after a fashion. For maximum efficiency in the unit being drained, though, the trick is to get it out without waiting for it to cool and without leaking steam.

Armstrong's water sealed valve takes care of steam leakage. The inverted bucket operating principle opens the trap for water regardless of its temperature. This means you get the condensate out as quickly as it accumulates. Result: *Higher temperatures and better heat transfer in steam heated units.*

A Steam Trap Should Remove Air and CO_2

Part and parcel of the condensate removal problem is removal of air as well as oxygen and carbon dioxide—two real troublemakers. Air tends to reduce operating temperatures and interfere with heat transfer. CO_2 goes into solution to form corrosive carbonic acid which, for example, can eat unit heater tubes. O_2 aggravates the situation. Believe it or not, but all traps don't properly remove air and CO_2.

By now, you've probably guessed that Armstrong traps *do* remove air and CO_2. Armstrong design (see illustration) provides continuous venting of air and CO_2. By opening suddenly, the Armstrong trap creates a momentary pressure drop to "pump" the air down to be vented. Result: *Higher temperatures, faster heat-up, better heat transfer and reduced corrosion.*

Note: When required, specially sized air vents are furnished. For fast heat-up of low pressure on-and-off units, Armstrong provides open float and thermostatic air vent traps.

What's the Final Answer?

Summing it all up, you'll get the best service from steam heated units that are equipped with traps designed to trap *all* the steam and remove air and condensate as quickly as it accumulates. In our prejudiced viewpoint, this means Armstrong traps. More important are the several thousand users of Armstrong traps who have proved the point.

Before you make up your mind, though, consider the minimum maintenance requirements of Armstrong traps . . . and the convenient assistance your local Armstrong Representative provides. These are important plus values.

Put Up or Shut Up

We're so confident that we "put up". Armstrong traps are unconditionally guaranteed to satisfy. So you can find out for yourself with practically no risk. If you're not completely satisfied with the way they do their job, you can get your money back.

* * *

The 44-page Armstrong Steam Trap book goes into greater detail on these and other Armstrong features. It also discusses trap selection, installation and maintenance. Ask your Armstrong Representative for a copy or write

Armstrong Machine Works
8106 Maple Street
Three Rivers, Michigan

ARMSTRONG STEAM TRAPS
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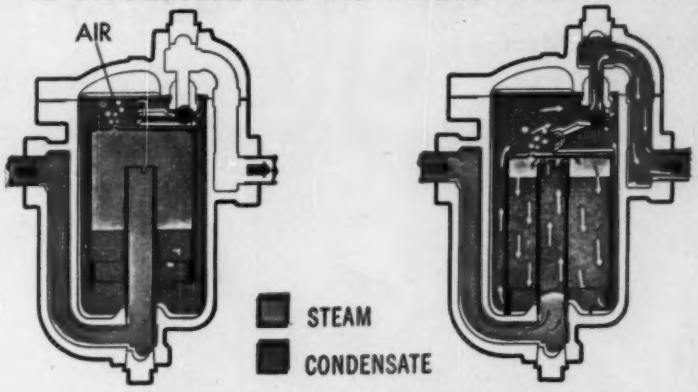
HERE'S THE STEAM TRAP DESIGN THAT GETS RID OF CONDENSATE AND AIR WITHOUT STEAM LOSS

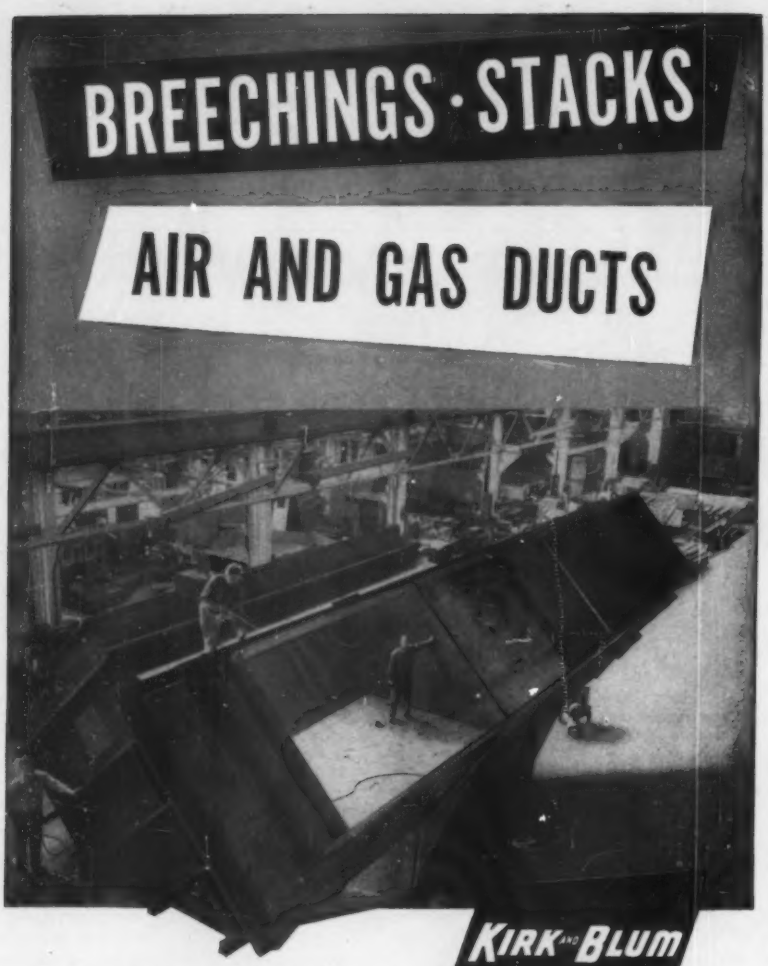


Trap closed. Steam has floated inverted bucket; valve is held tightly closed by system pressure. Air entering trap passes through bucket vent and accumulates at top of trap.

Trap open. Condensate entering trap has caused bucket to lose buoyancy. Weight of bucket times leverage pulls valve open. Air is discharged along with condensate.

See our catalog in Sweet's Plant Engineering File

For more data circle 538 on Post Card



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Kirk & Blum has fabricated a variety of power plant needs as big as the mammoth breeching section shown here. In a 150,000 sq. ft. plant, with crane capacity to 25 tons, Kirk & Blum has complete facilities to produce, preassemble and load the largest fabrication. Kirk & Blum has the men, materials and experience to do the job quickly and economically.

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FABRICATION

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Newark, N J. — Public Service Electric & Gas Co, 80 Park Place, has announced the beginning of operations at its Bergen Power Station, on Overpeck Creek, Ridgefield, N. J. New plant is equipped with two steam electric generating units, each with a capacity to produce 290,000 kw. Plant was recently completed at a cost of $110,000,000. More than 5700 piles were driven into the earth to support the 260,000 tons of buildings and generating equipment at the station. Over 7500 tons of structural steel were used in the construction of the plant and superstructures for the generating equipment. It is estimated that during the first year of operation the plant will burn as much as 4000 tons of coal each day.

Poughkeepsie, N. Y. — Central Hudson Gas & Electric Co, South Rd, has announced that it plans to complete purchase of a large tract of land comprising about 768 acres for a new power plant on the upper Hudson River. Decision to go ahead with the property was made after test borings had proved that a large electric generating station could be built on the site. Cost of the property, which is made up of the 56-acre Cruger's Island and 712 acres of mainland immediately adjacent to it in the town of Red Hook, N. Y., was reported to be about $750,000. Site is located about 25 miles north of here on the east bank of the Hudson River. Detailed plans for the size and construction of the power plant will be announced later.

Portland, Ore. — Portland General Electric Co, 610 S.W. Broadway, this city, has announced that the Federal Power Commission has authorized the company to build the proposed $70,900,000 Round Butte power project on the Deschutes River in Jefferson County, Oregon. New project, which will include a 440-ft-high rock-fill dam, is planned to have an installed capacity of 247,050 kilowatts, with an estimated average annual output of 925,000,000 kilowatt-hours. Project, to begin at once, will be the largest located wholly within this state and will almost double the output of the company's seven existing power developments. The Round Butte license will be effective for 50 years from January 1, 1952, as part of the company's existing Pelton project because the dams will be operated as a unit.

Johnstown, Pa. — Pennsylvania Electric Co, 222 Levergood St, this city, a subsidiary of General Public Utilities Corp, has announced that it has recently placed in operation in company's system a 13-mile, 460,000-v transmission line. Completion of the project marks the first time that power of this high voltage has been transmitted in the United States. Previous to this operation, highest voltage lines in use have been 345,000 v. Company spokesman stated that the new line was in the nature of an experiment, and, if successful, would lead the way to moving large amounts of power over longer distances than is currently possible.

Williamsport, Pa. — M. K. Kellogg Co, 711 Third Ave, New York, N. Y., has announced that it has completed the most modern plant ever designed specifically for the manufacture of power piping for electric generating stations. It is now in production at this location. Plant recently completed at a cost of $4,000,000 is equipped with the latest machinery for machining, bending, and welding ferritic, austenitic, stainless and other materials into piping of any wall thickness, and is estimated to have cost in excess of $1,000,000. Testing equipment for quality

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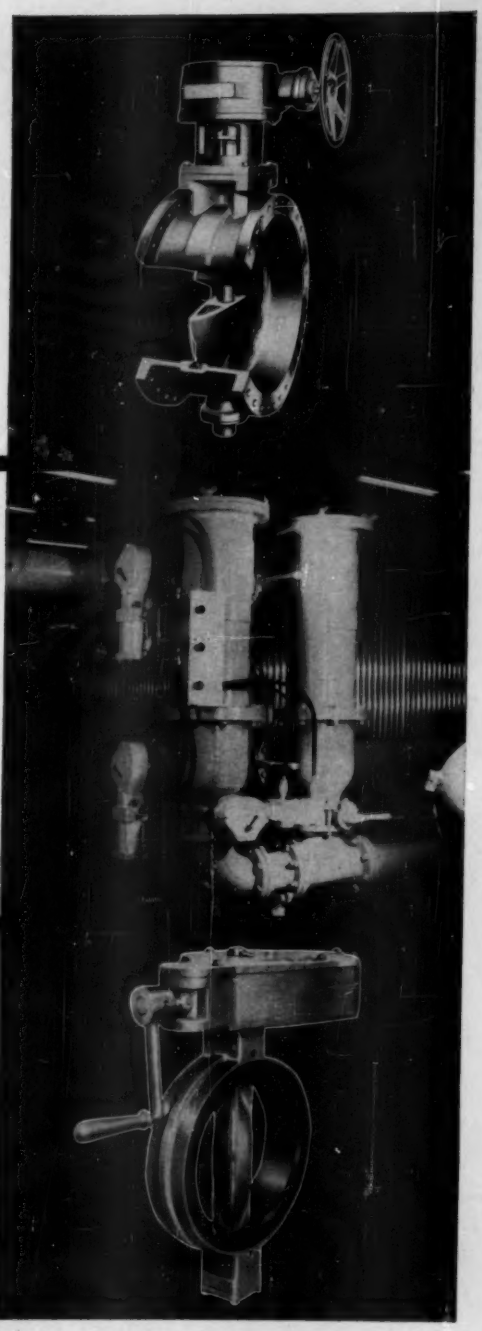
NEW Rubber Seat Butterfly Valves

The time-proven Henry Pratt features are now augmented by such new design features as: ADJUSTABLE SEAT that can be tightened, or even replaced without removing shaft or disc. LOWER SEATING TORQUES, lowers actuator cost and provides remarkable ease of operation. Longer operating life through accurate control of disc-seat interference, giving tightness, without wear.

The new Pratt Butterfly Valves are available in sizes 3" through 144" and for pressures to 150# in both wide and narrow face-to-face. Also furnished with integral expansion joint.

Write for complete information.



NEW PRATT CYCLONE STRAINER

The new Pratt Cyclone Strainer eliminates the manual cleaning usually associated with this type of equipment. Backwashing operations are completely automatic and can be accomplished in seconds.

Unique design simplifies piping and installs for *far* less than ordinary designs.

Patented "Cyclone" action keeps larger particles away from basket—keeps strainer "on the line" longer.

Features rubber seat butterfly valves for longer life and positive action. Manual or automatic valve operators.

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NEW Monoflange Mark -II

No valve is easier to install or operate. The Monoflange fits between existing pipe flanges—no gasket is necessary. With completely tight shut-off at 150# psi, the Monoflange Mark II finds many applications where economy is paramount, but long life is necessary.

New "Sidewinder" manual operators are available for standard or buried service with crank, handwheel or chainwheel. Cylinder, Diaphragm topworks or electric motor operators also available.

Write for Bulletin B-10-G.

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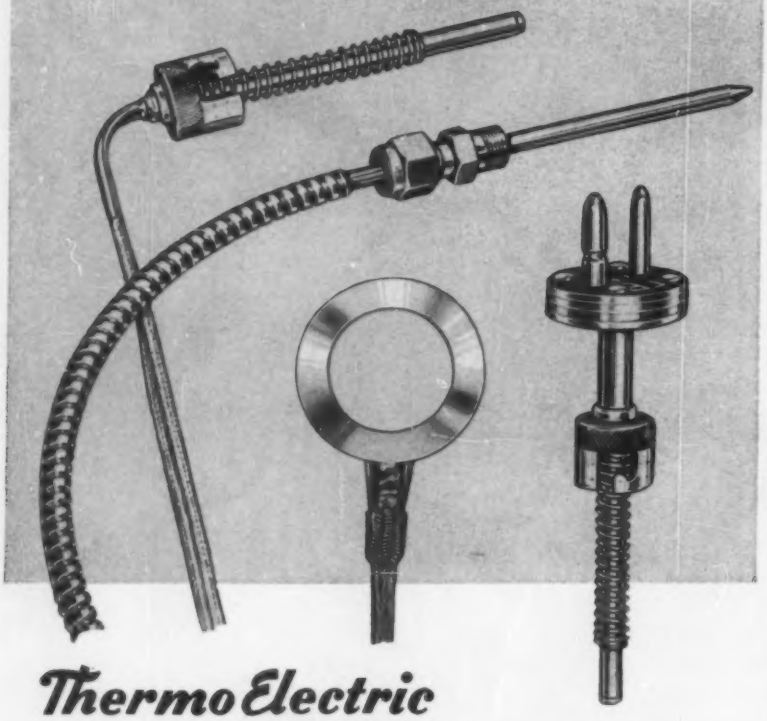

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Miniature Thermocouples

You can obtain a Thermo Electric Miniature Thermocouple for peak performance and economy in almost every application! Those illustrated are available in a wide variety of sizes, standard thermocouple materials, adapt to many applications.

Protected thermocouples are extremely sensitive, give fast response to minute temperature changes. The measuring junction is welded or silver soldered to the tip of the thin-walled "Ceramo" metal sheath. Ideally used in corrosive liquids or gasses—and many pressure applications. For quick-coupling versatility, the spring-loaded bayonet-lock thermocouple is tops! You can use one "couple" at various depths with different adapters. With spring-loading, tip contact is always maintained. The bayonet type is highly sensitive, fast responding, for use in pump and engine cylinder heads, turbine housings, pipes, electric motors, generators, plastic extruders and molding machines.

Gasket Thermocouples measure surface temperatures in all sorts of stationary or moving machinery.

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control includes the latest in electronic, radiographic, and ultrasonic advances.

Amarillo, Texas — Southwestern Pubic Service Co, Third & Polk sts, has announced approval of plans for a major expansion and improvement program of its power station located here. Plans include extensions in generating facilities, power substations, transmission lines and other operating facilities. Company has awarded contract for the work in the amount of $14,000,000 to Missouri Valley Constructors, also of this city. Work will begin at once and is scheduled for completion by the summer of 1962.

Austin, Texas — City Department of Light & Power, City Hall, has authorized plans for improvements and expansion in the municipal power-transmission system. Work will include installation of electrical transmission lines, transformers, distribution circuits, services, meters and related work. Work already under way will be completed early in 1962.

Milwaukee, Wis. — Milwaukee Gas Light Co, 626 E. Wisconsin Ave, is considering plans for the construction of a large new service center to be located on the north side of this city. Plans for the proposed one-story reinforced concrete and steel service center have been approved and work will begin soon. Fritz von Grossman, 5455 W. Burleigh St, Milwaukee, is the architect of the new headquarters building, which will cost approximately $3,500,000 when completed late in 1962.

Wisconsin Rapids, Wis. — Consolidated Water Power & Paper Co, major supplier of coated printing papers, has announced that it has begun excavation for an expansion of its Wisconsin River Div, at Whiting, Wis. Plans include corresponding increases in auxiliary facilities necessary to the start-up of a new, large paper machine. These would include enlargement of the boiler house, steam boilers and auxiliary equipment, ground-wood pulp and bleach departments, coating plant, finishing facilities and stores.

Washington, D. C. — The Atomic Energy Commission, 1901 Constitution Ave, N.W., has announced issuance of an operating license to the Martin Co, of Baltimore, Md., to test an advanced nuclear power reactor concept. The Martin approach, being developed under an AEC contract awarded last fall, eliminates the neutron-absorbing control rods which are required in most reactor designs to regulate the rate of nuclear fission, moving in and out of the uranium fuel elements. Martin's liquid-fluidized-bed reactor substitutes a bed of pea-sized pellets of enriched uranium suspended in water. Company has claimed that this development, at a cost of $838,162, promises to produce power at a fuel cost comparable to that of conventional fuels anywhere in the world.

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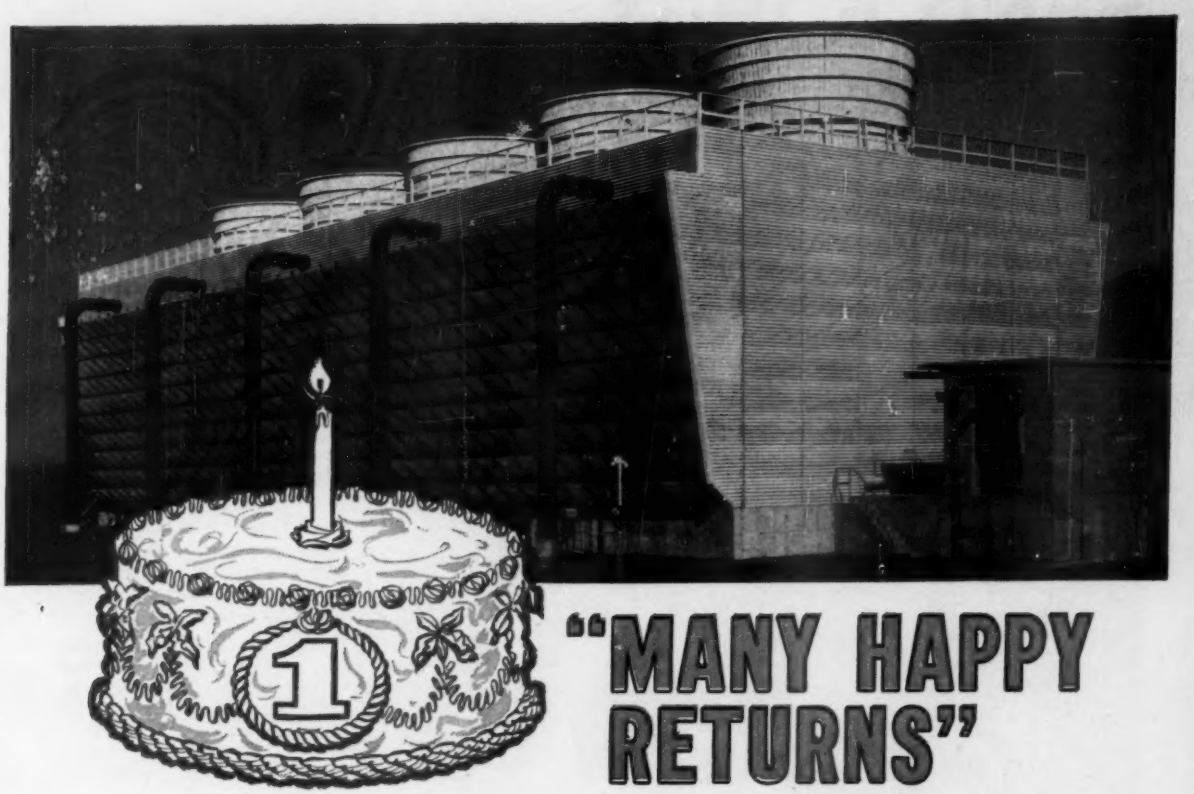

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This Class 600 Marley Double-Flow cooling tower is one year old . . . and in excellent condition functionally, mechanically and structurally. To assure many more "happy" anniversaries over a long future, The Marley Company will never relax vigilant attention to every detail of its welfare.

Like all Class 600 towers, it will be under the surveillance of a member of the Marley Service Engineering staff, experts on cooling tower operation and maintenance. The results of their services are best attested by supervisory engineers and executives in plants where Class 600 towers are now in service:

ENGINEER, GENERATING STATION:

"We have greatly appreciated the service you have rendered. We had little experience with towers before these four units were put in operation, but we have received much help from your service engineer. Periodic inspection by someone who knows towers relieves us of the worry of letting our towers degenerate. Our supervisors always look forward to these visits and have plenty to discuss with your engineers. Your service has been good and we hope we can continue along this way with the new tower which you will soon be building here."

MANAGER, NUCLEAR PLANT:

"It is our opinion that mutual benefit has been derived from the periodic visits of your service engineer. We know that this service has given us experienced assistance in operational, mechanical and wood deterioration problems."

REFINERY ENGINEER:

"The Marley service engineer has been a most helpful person to work with and has always been ready to come and help us. His recommendations have been fair, honest and unbiased. That is why we have always accepted them. We would be very disappointed if this service was not available; we have come to depend on it."

MUNICIPAL POWER SUPERINTENDENT:

"From the power plant operator's point of view this is the best service you can give! I will welcome your service engineers at all times. There are many pieces of equipment in a power plant and it is impossible to give each piece of equipment the loving care that the manufacturer would like it to have. Therefore, I welcome an opportunity to discuss, with service engineers, the operation and maintenance of any piece of equipment in the plant. Your service engineers have been most courteous and helpful. I hope that I shall see more of them in the future."

PETRO-CHEMICAL PLANT MANAGER:

"We have found the attention of Marley service engineers beneficial to our cooling tower operation and maintenance. In particular, we appreciate the latest inspection of our towers. This service has been helpful to our preventive maintenance and cooling tower repair programs. We are looking forward to working with your engineer during an early visit."

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Hagatreat, an entirely new concept in the treatment of cooling water, prevents scale and sludge formation in the system and permits higher concentration of make-up water. Results, savings in both chemicals and water costs. In tests covering several years, corrosion of both steel and copper was held to a minimum unmatched by any previous inhibitor.

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New Engineering Books

Engineer's Vest Pocket Book; 192 pages, 2⅝ by 5½ in. Published by Ottenheimer Publishers, Inc, 4805 Nelson Ave, Baltimore 15, Md. Price 90¢.

Here in a book about the size of a case for eyeglasses is crammed plenty of information which the engineer might need many times on his job. Contained within: Formula for the Binomial Theorem, properties of structural steel, strength of gear teeth, the properties of saturated and superheated steam, resistance of an immersed body moving through fluid, thermal stress, resistance, veniers, cost estimating, properties of minerals, and chemical solubility. In addition to these topics there are 250 other main items and 47 important charts.

An alphabetical index, an index of charts and tables, and 12 marginal indexed headings are other important features. The indexed headings list: Mathematics, Building, Mechanics, Heat, Hydraulics, Pipes, Electricity, Surveying, Costing, Mining, Chemistry, and Miscellaneous Data.

★ ★ ★

Handbook of Chemistry and Physics, 42nd edition — 1960; 3481 pages, 5 by 7½ in. Published by The Chemical Rubber Publishing Co, 2310 Superior Ave N. E., Cleveland, Ohio. Price $12.

Latest edition of this well-known and very useful handbook is just off the press after being revised and brought up to date for the forty-second time.

Representing the work of over 200 prominent collaborators, this book is the only one-source reference covering mathematics, physics and chemistry in one volume. The material is divided into five indexed sections: Mathematical Tables, Properties and Physical Constants, General Chemical Tables, Heat and Hygrometry, and Quantities and Units.

Among the revised, expanded, and updated data and information are: atomic weights, electronic configuration of the elements, trade names of plastics, analytical reagents, volumetric primary standards, efficiency drying agents, properties of refractory materials, nuclear spins, and definitions.

Among the new tables included in this edition are: diffusion of metals into metals, diffusion of solute elements in body-centered cubic titanium and titanium alloys, triple points and boiling points of some low boiling elements, dissociation pressure of calcium carbonate, initial permeability of high purity iron at various temperatures, interplanetary orbits, components of atmospheric air, bond lengths between carbon and other elements, sublimation data for organic compounds, standard types of stainless

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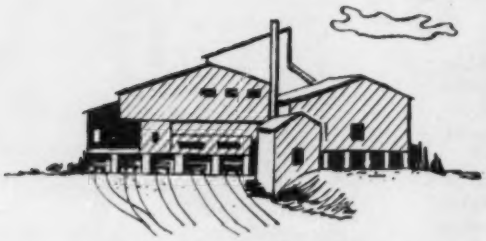

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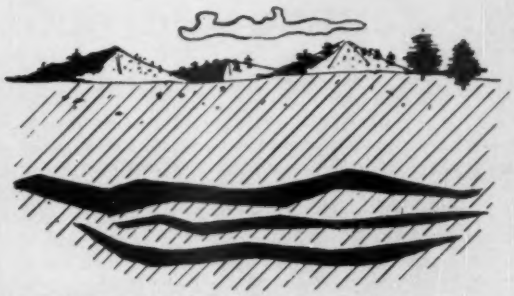

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The great reserves of unmined coal owned and leased by The Valley Camp Coal Company assure our customers a dependable source of quality coals far into the future.

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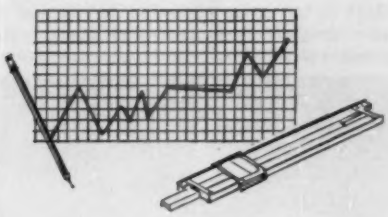

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Our combustion engineering service exists for one purpose, to assist our customers in getting the lowest possible steam costs with Valley Camp Quality Coals.

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Strong and husky, Elliott type YR turbines make dependable, economical drives for pumps, compressors, fans, line shafts, generators and other equipment. All-weather protection assures dependable operation under all conditions of heat, cold, moisture, dust and contaminated atmosphere.

The governor is simple and reliable, and is available in several modifications to match speed and pressure control requirements. YR turbines are designed for easy installation and service. Many key parts are interchangeable for various frame sizes. Two sizes are shown below. Write for descriptive bulletin H 22-D. HO-3

ELLIOTT Company
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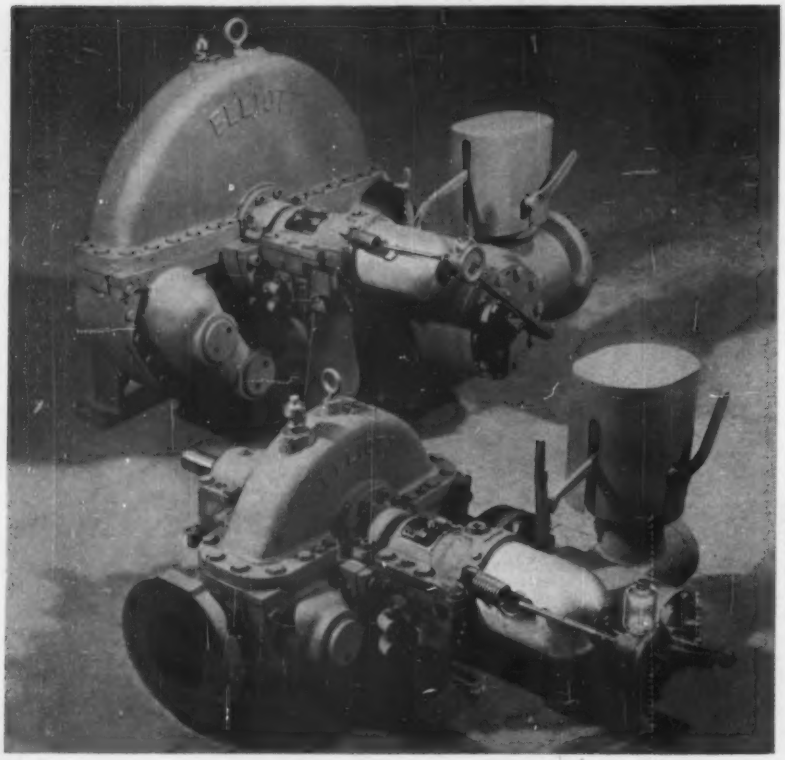
In addition to the units illustrated here, Elliott makes single-stage turbines in special frames, reduction gears, multistage mechanical drive turbines to 50,000 hp, and turbine-generators through 44 mw.



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steels, solutions giving round values of pH at 25 C.

Everyone engaged in the science fields will welcome this new edition.

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Symposium on High-Voltage Cable Insulation — STP 253, 39 + V pages; 6 by 9 in; heavy paper cover. Available from ASTM, 1916 Race St, Philadelphia 3, Penna. Price $1.50.

Necessity of transmitting ever-increasing amounts of electric power has forced the use of higher and higher voltages in power cables, some in excess of 300 kv. This symposium presents the views of experts on the problems associated with producing cables safe and reliable enough to handle these high voltages.

Jointly sponsored by AIEE Subcommittee on Insulated Conductors and ASTM Committee D-27 on Electrical Insulating Liquids and Gases, the volume is extensively referenced and is the eighth of a series on insulating oils.

Papers include: Introduction by V. R. Mulhall, Canadian G.E. Co; Paper for High-Voltage Cables, by W. A. Del Mar, Phelps Dodge Copper Products Corp; The Why and How of Cable Oil Tests, by R. B. Blodgett, The Okonite Co; and The Utility Viewpoint on Cable Oils, by A. M. Gates, Philadelphia Electric Co, and R. M. Gillette, Consolidated Edison Co of New York.

★ ★ ★

Fuel Abstracts and Current Titles, 6½ x 7¾ in. Published by The Institute of Fuel, 18 Devonshire St, Portland Place, London W. 1, England. Annual subscription $36 (12 guineas), including index and postage. Special edition, printed one side of paper only for filing purposes, may be obtained for $44 annually. Single monthly issues are $3.50, and the annual index purchased separately is $5.

This is a new publication: a monthly classified summary of world literature on all the scientific and technical aspects of fuel and usage, and it will be supported by comprehensive author and subject indexes. The publication is a development of that formerly prepared by the Dept of Scientific and Industrial Research, which ceased in December 1958. It is an invaluable guide for research workers, information officers, and librarians, whether in universities or in industry.

All fields of fuel extraction, preparation, and usage are covered under 20 subject headings. Usage is very broadly interpreted to include new burner designs, fuel injection pumps, and all prime movers. Boiler design and operation, hydro power, solar furnaces and energy conversion, fuel cells, nuclear reactors, rockets and space flights, tidal power, air pollution, heat pumps and heating systems are all covered.

It appears that all subjects are classified that have anything to do with fuel, or the production of heat or power from whatever source.

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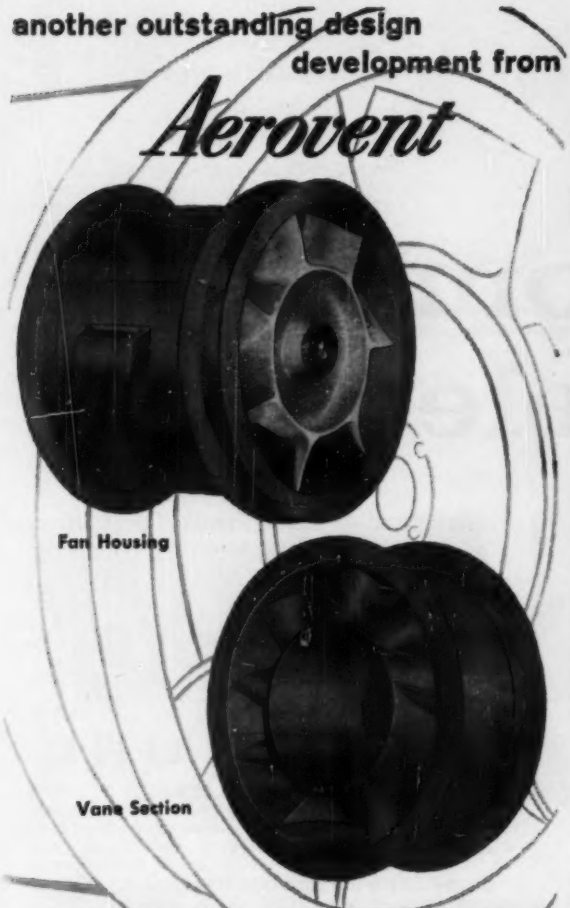

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Write for Bulletin 475

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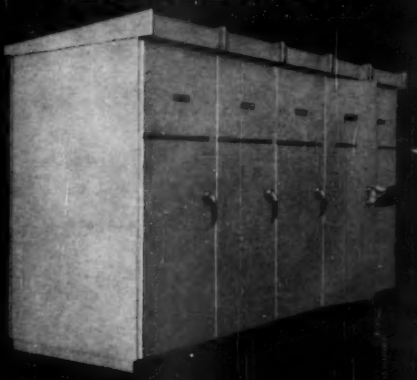

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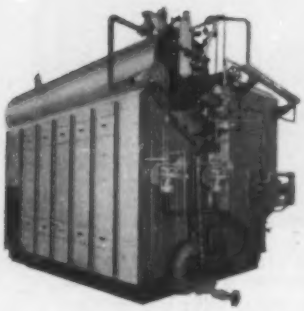

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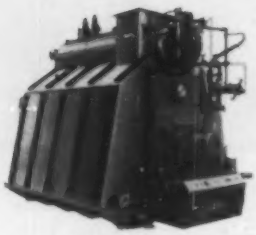

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Current Catalogs

continued from page 30

156 Instrumentation Tubing — Basic facts about all types of small diameter tubing for instrument applications are presented in Superior Tube Co.'s 12-pp Bulletin 380. Covers applications, required characteristics, materials specified, size range, length, tolerances and tempers.

157 Capillary Inking System — A cartridge-type capillary inking system for recording instruments is described in Bulletin RM-40002 released by Controls Div., Hagan Chemicals & Controls, Inc. Diagrams showing details of operation are included, along with specifications.

Water, Waste Management

158 Anion Exchangers — Advantages of porous type highly-basic, quaternary amine polystyrene exchange resins for silica removal in individual or mixed bed demineralizing plants are discussed in this 8-pp bulletin by Ionac Chemical Corp. Contains flow charts, tables and other illustrations.

159 Dry Chemical Feeder — Technical information on dry chemical feeders used for a broad range of water and industrial waste process applications is presented in Catalogs DF-78 and DF-60 issued by The Permutit Co. Operating data on the volumetric feeder and installation details are included along with specifications.

160 Return Line Corrosion — Causes of corrosion in condensate return lines are discussed in this water conditioning data sheet released by Betz Laboratories, Inc. Tells how these causes can be identified and economically corrected.

161 Combustion of Sewage Sludge — Low temperature combustion of sewage sludge is detailed in this 20-pp bulletin, issued by Zimmermann Process Div., Sterling Drug Inc. Describes the process which burns sewage sludge in its aqueous state without flame, and includes flow chart, conversion chart, equipment and operational results, and design data.

Other Equipment

162 Grating and Treads — Characteristics of Dravo Corp's steel industrial grating and facilities for its manufacture and fabrication are described in 12-pp Bulletin 1112. Design, panel widths and load tables are detailed, as are typical clearances and various types of fasteners for installation.

163 Seamless Welding Fittings — Eight-pp Bulletin FB-502A covers seamless welding fittings and flanges in carbon, alloy and stainless steels. Includes charts of standard sizes and schedules, dimensional tolerances, illustrations of commonly produced fittings and flanges. Bulletin is released by Tubular Products Div., Babcock & Wilcox Co.

164 Industrial Apparel — Described in this 16-pp catalog of Worklon Inc. is a line of acid resistant, lint-free and static-free apparel designed for industry's

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varied requirements. Included with the catalog is a handy swatch card of actual fabric samples.

165 Water-Cooled Condensers — Eight-pp Bulletin WC-300, of Halstead & Mitchell Co., describes mechanically cleanable water-cooled condensers for refrigeration and air conditioning. Emphasizes advantage of true counterflow for maximum heat exchange over total tube lengths. Condensers listed are refrigeration and air conditioning systems requiring minimum space; sizes range from ¼ to 25 tons. Charts showing water consumption and pressure drops are included.

166 Dust Control Equipment — Illustrated and described in 12-pp Bulletin 271 of American Air Filter Co., Inc. are four main types of dust control products — dry centrifugals, wet collectors, fabric collectors and electrostatic precipitators. Covers capacities and specific applications.

. . . *Outstanding Among This Month's Catalogs*

167 Corrosion Computer — This corrosion computer, offered by The H. M. Harper Co., works like a slide rule and tells how each of eight types of metal withstands the corrosive effects of 141 chemical agents. Metals are common in mechanical work — brass and naval bronze, silicon bronze, monel metal, stainless 410, 416 and 430, stainless 302, 303, 304 and 305: stainless 316, copper and aluminum.

168 Three-Dimension Models — Advantages of using three-dimensional scale models in planning new construction, expanded facilities, improved utilization of space etc. are treated by Knight Models Inc. in this 8-pp bulletin. Illustrates some individual product models as well as industry groups of equipment and installations in foundry, machine shop, steel warehouse, extension to power station.

169 Tips on Welding — This 56-pp welding, brazing and soldering alloy and flux catalog and instruction manual issued by All-State Welding Alloys Co., Inc. covers physical properties, major uses, detailed application instructions and latest techniques for welding, brazing, soldering, cutting and hardfacing. Charts and tables summarize alloy selection and properties.

171 On Mounting Tubing — This 76-pp Engineering Design Manual (Bulletin 212 G) by TA Mfg. Co. offers a compiled listing of materials and specifications, recommended application and latest technique for mounting tubing, wiring and similar hardware. Also includes description of complete line of clamps, brackets, shims and line supports.

172 Organic Chlorine Compounds — This 44-pp catalog released by Union Carbide Chemicals Co. describes use of organic chlorine compounds as solvents, extractants, fumigants, intermediates, and special-purpose fluids. Contains comprehensive data on 13 organic chlorine compounds, including physical properties, cleaning formulations, toxicological properties, storage and handling, test methods, and selected literature references.

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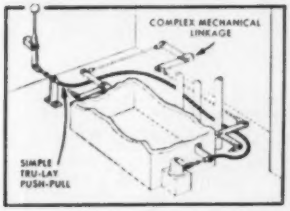
TRU-LAY PUSH-PULL DATA FILE SHOWS HOW TO SIMPLIFY AND IMPROVE DESIGN



Push-Pull remote controls, shown here, are flexible, have but one moving part, and give a lifetime of accuracy. Mechanical linkages are complex, are made of many parts, wear at many points, and produce increased backlash, lost accuracy, and vibration rattles.

This Push-Pull Data File—containing 7 engineering bulletins—will show you how these flexible controls have eliminated mechanical linkages on hundreds of products. You can make *your* products more useful, easier to sell, with Push-Pull controls. Write for your Data File today.

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Eliminate ear splitting fatiguing plant noise from exhaust vents with patented PULSCO Blowdown Mutes. Capacity: From 1,500 to 500,000 cfm air and gas, 3,000 to 1,000,000 lb/hr steam. Temperatures to 1,200° F. Overall sound pressure level reduced to 80 - 86 decibels at 100 ft. Excellent silencing plus separating and collecting condensate. Drain provided.

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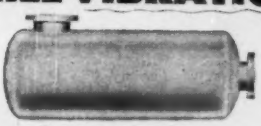

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Equipment News

Described on these pages are new and improved products. Use Reader Service Cards on pages 103–104 to ask for more information on them. Just circle the item numbers of all the products in which you are interested.

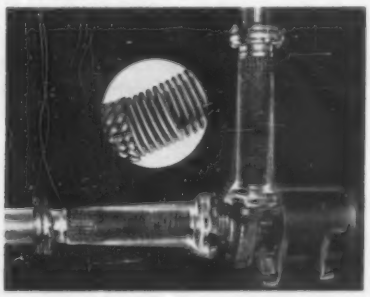
1—Safety switches withstand 200,000 amp short circuits

General Electric Co. has introduced heavy duty (Type TH) and heavy duty interrupter (Type THD) switches claimed capable of withstanding the tremendous energy of a 200,000 amp short circuit when used with G-E CLF high capacity or other current limiting fuses of comparable characteristics as defined in NEMA Standards FUL-1959. Employing silver alloy, refractory-type contacts of the kind used in molded case circuit breakers, THD switches are available in ratings from 30 to 600 amp, 250 and 600 v a-c. Type TH devices, available in same ratings, incorporate double-break contacts imbedded in a phenolic rotor.

2—Flexible connectors for pumps and pipelines

Troublesome effects of pipeline vibration, misalignment, or thermal expansion in pump installations are said to be absorbed or reduced by H. A. P. Flexible Pump Connectors, introduced by Allied Metal Hose Co. Consisting of a short section of corrugated flexible metal tubing, protected against pressure elongation by wire braid, these connectors have threaded or flanged end connections to fit standard piping sizes; are available from ¼ through 16 in. in stainless steel, ¼ through 8 in. in bronze and hot-dip galvanized steel, and ¼ through 4 in. in Monel.

The units are designed to handle pressures to 1500 psig, depending on alloy, braid construction and size. Manufacturer points out that their helical, rather than annular, corrugations offer less resistance to flow, while distributing stresses along entire hose length to minimize localized failures. Safety factor of each hose unit is given as four times rated working pressure.



3—Fuel oil additives promote boiler efficiency

Two additives formulated to increase boiler efficiency, reduce maintenance and extend equipment life are announced by Dearborn Chemical Co. Dearsol 30 is a combination sludge dispersant and combustion catalyst made to prevent clogging of strainers, burner tips, filters, oil lines and oil preheaters. Dearsol 35 is a liquid organic catalyst soluble in residual fuels at all use concentrations, formulated to release maximum Btu's in every gallon of oil and eliminate soot and carbonaceous deposits. Where sludge is not significant, Dearsol 35 may be the only additive needed.

4—Metering transformer of epoxy resin construction

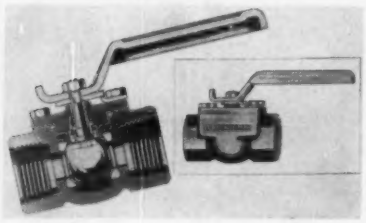
This epoxy-porcelain window-type heavy-duty high-current metering transformer, designated Type BKAW-M by Allis-Chalmers Mfg. Co., is available in 5-, 8.7- and 15-kv insulation classes in current ratings 1000 through 4000 amp. Toroidal windings on a wound core are enclosed in expoxy resin which serves as insulation, support and case for transformer element. Porcelain sleeve in transformer provides insulation for the primary conductor. It is impervious to acid and salt atmospheres, says manufacturer; it requires no maintenance or painting, installs in any position.

5—Torque limiter prevents damage to motors, drives

The Torque-Master XB-150 is an off-the-shelf device introduced by Roberts Aircraft Engine Co. to prevent damage to motors and drives by constantly disengaging power upon overload and jam-ups. Interchangeable bushings are used from ½ in. to 1 1/16 in. bores. Single-, double-, triple-groove sheaves and sprockets are made to fit without machining. Unit can be adjusted manually to release and "sound-off-alarm" at any predetermined torque setting from 10 lb, ft to 150 lb, ft, or can be locked in positive drive with no release. It acts as an automatic shear-pin mechanism, slipping only when jam-up occurs and re-engaging when overload is relieved. Company says torque output remains constant when exposed to changing temperatures, weather, oil and abrasive conditions.

6—Ball valve has top entry design for easy maintenance

Fig. 700 Ball Valves of Lunkenheimer Co. are introduced in bronze body, screw ends, pipe sizes ¼ to 2 in., with



Teflon or Buna-N seats and seals. Top entry design makes possible easy in-line maintenance — the "hook" on the handle is used to "flip" the ball for access to seats. Ball is flat on top and bottom, so it can be removed without breaking pipe. Self-aligning ball is made to ride on its seats, sealing at high or low pressure without springs or bearings.

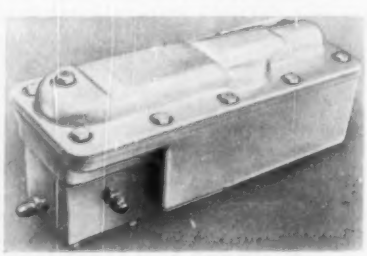
7—Multi-purpose desk adapts to engineering office needs

This design-drafting unit, introduced by Hamilton Mfg. Co., converts readily into an office desk with two files. It has

a 43½-by-72 in. linoleum drawing surface with roll-holding brackets to simplify handling of large drawings. Files may be used independently of board if desired. Entire assembly consists of the steel, linoleum covered top and two files. Bar type security lock protects confidential material.

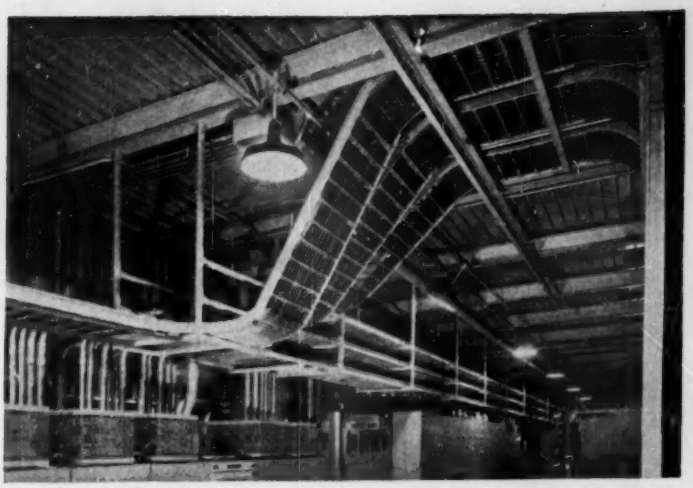
8—Electro-pneumatic unit converts d-c to pressure signal

The PowrMag Converter, a development of Hagan Chemicals & Controls, Inc., accepts electrical input signals of



1-9 v or milliamps d-c, or 1-5 v or milliamps d-c. Pneumatic output signal ranges are 0-30, 0-15, 3-27, 3-15 psi, or the inverse of these ranges. With an overall accuracy of 0.5 per cent of full scale, the converter's electrical system is temperature compensated to maintain

how INLAND STEEL uses GLOBE INTERCHANGEABLE TRAYS to support cables in their Indiana Harbor Plant



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★ Complete Accessories for SPEEDIER Installation
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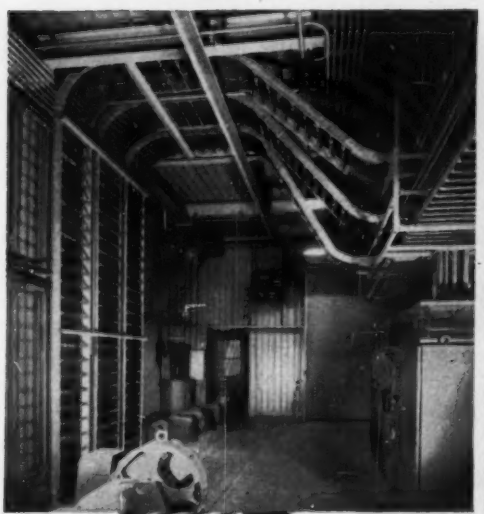
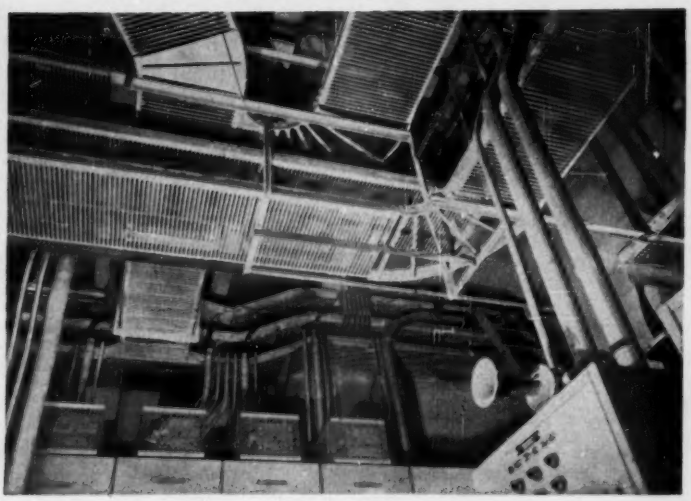
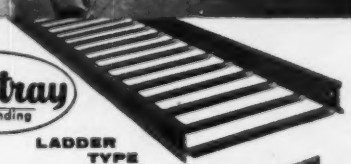
★ No Sharp Edges to Damage Cables





Globetray
Pat. Pending



LADDER TYPE

BASKET TYPE (One-piece construction)

Globe's two types of cable trays, one a ladder type and the other a basket type, to support cables, wiring and tubing have become increasingly popular because they can be used INTERCHANGEABLY at any given location depending on the type and weight of the cables to be suspended. The advantages of each type tray can be used to the fullest. Globetray, the ladder type, is intended for use where festooning is not a problem, while Cable-Strut, the basket type, is used for the support of communication wire, instrument tubing and control cables in automation applications.

These two cable trays have been thoroughly field tested in hundreds of large industrial installations, in new plant construction, in power plants and for power distribution in all types of manufacturing processes. Send for FREE catalog giving full information and installation techniques.

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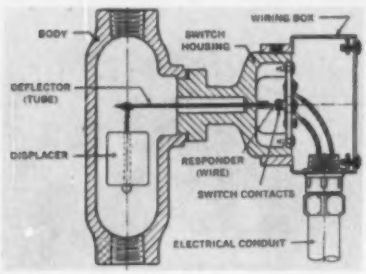
accuracy over a wide range of conditions. Temperature coefficient is given as 0.25 per cent per 100 F on range and 1 per cent per 100 F on zero. Additional information is in Bulletin MYP 722A.

9—Sensing device detects, controls process variables

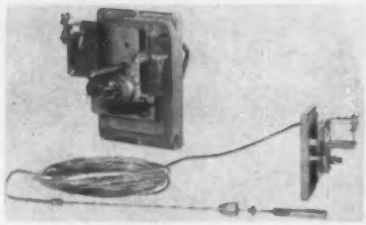
Offered by Yarnall-Waring Co. is a sensing device employing the W-I-T (wire in tube) element for transmitting motion through a pressure-tight wall without bellows, seals or stuffing boxes. This element consists of a flexible,



curved tube containing a spring wire. Deflection of the end of the tube by a change in level, flow or other variable causes a rotation of the wire, which in turn may indicate the change or operate a switch. The compact element can be used to indicate or control critical levels on boilers, heaters and similar pressure vessels, and to control flows. It can actuate alarms, cut off fuel supplies, start and stop pumps.

10—Annunciator provides printed record of plant events

Introduced by Scam Instrument Corp., this recording annunciator prints selected "off normal" and "return to normal" conditions at the command of a variety of simple contact devices . . . pressure or temperature switches, limit switches, overspeed switches, and overload relays. The printed record includes the specific condition and the month, day, hour, minute and second of occurrence. The unit is designed to pinpoint operating deficiencies; relieve operating personnel of logging duties; eliminate chance of human error; and provide 24-hr vigilance. Three basic models provide 32-, 64- and 1000-point maximums.



12—Temp measuring system plugs into receiver-recorder

Introduced by Bailey Meter Co. as a standard plug-in unit for its receiver-recorder, this mercury-filled temperature measuring system is described as having a minimum capillary ambient temperature error and a wide range of span suppression. The bourdon tube element in the system designated Class 4RD, plugs into any of four positions in the recorder. Plain or coiled bulbs sense temperatures from −39 to 1200 F, and transmit them to the bourdon tube element along capillaries up to 200 ft long. Capillary ambient temperature error is said to be limited to approximately ½ per cent per 200 F per 100 ft. A variety of standard ranges are available in the system from 0-200 to 0-1200 F. Suppressed ranges are also available.

13—Circuit breakers offer economical high speed protection

Low-voltage, current-limiting K-Don Circuit Breakers are introduced by I-T-E Circuit Breaker Co. for economical high-speed protection against fault currents up to 200,000 amp. These breakers integrate — in a single switchgear compartment — fast-acting, high capacity fault protection of company's Amp-trap current limiting fuses with the protective features of its K-line stored-energy breakers, and a device that prevents single phasing, it is stated, and without sacrificing adjusting flexibility needed for overcurrent and medium-capacity short-circuit tripping. They provide fault protection for the system, the breaker itself, load-side equipment, and operating personnel.

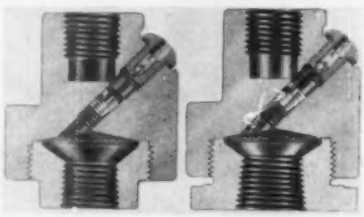
Among application possibilities are replacement of existing breakers where available short circuits, due to system expansion, exceed breaker interrupting capacity; protection of panelboards with limited interrupting capacity; and protection of low-voltage bus duct.

14—Computer makes three basic process computations

An analog computer designed to perform any one of three mathematical functions most common to process control is introduced by Swartout Div. of Crane Co. for use with company's Autronic Systems. The computer, the C4A 2, can extract the square root of a single input or ratio or multiply two inputs from a primary transmitter. Its output signal is the analog value for the given mathematical function, and can be used to directly operate a recorder, indicator or controller. It permits electronic instrumentation to be utilized for many control functions formerly requiring pneumatic systems. In pumping stations the C4A/2 can be the basis of a system controlling compressor horsepower according to simple computations made by multiplying pressure by flow. Fuel-air rations can be obtained by using the computer to divide appropriate flow values, and flow blending systems of all types can be designed around its ability to ratio two streams. Specification A-810 provides data.

15—Accessories improve protection of pressure gages

Similar in design, a pulsation dampener and a chemical attachment are announced by United States Gauge Div. of American Machine & Metals, Inc. as offering improved performance and easier maintenance where gages must be protected from pulsating pressures or



corrosive chemicals. Both have a diaphragm (stainless steel or Neoprene) separating measured fluid from gage measuring element, as shown in the cutaways. Space above the diaphragm is filled with a viscous non-freezing liquid which transmits measured pressure to the gage element. For pulsation dampening, there is an adjustable restriction in a passage from diaphragm top to gage. A feature is that it permits access to this passage at the side of the unit — you don't have to unscrew the gage to fill the top chamber.

Gages equipped with the dampener can be used with fluid temperatures from 50 and 100 F without temperature correction. The chemical attachment is designed to prevent measured fluids from clogging or corroding the gage spring element. In addition, it can also be used for pulsation dampening.

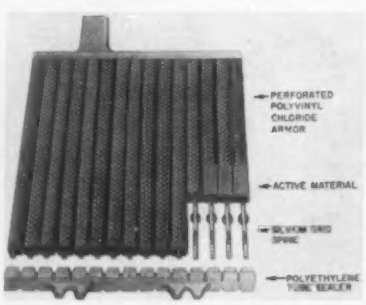
16—Resin cleaner for cation exchange water softeners

A blend of inorganic chemical agents with high dissolving and dispersing properties, Cation Exchange Resin Cleaner 1112 has been developed by Ionac Chemical Co., Div. of Pfaudler Permutit Inc. to clean and lengthen life of cation exchange resin beds in installations requiring salt regeneration. Dissolving rapidly in cold water, cleaner removes contaminating coating from

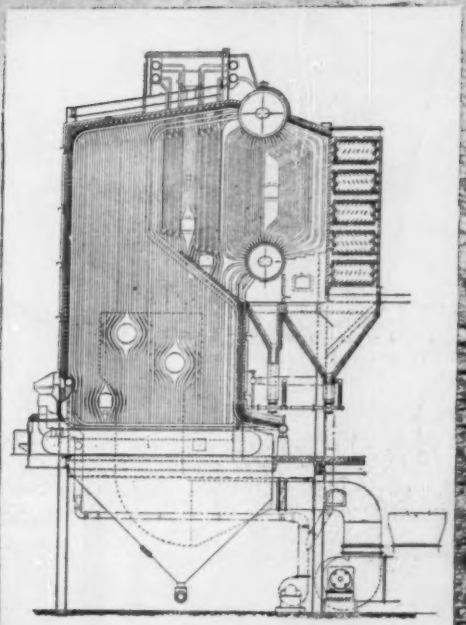
11—Storage battery, for stationary service, extra powerful

Because it is so powerful and will last an estimated 20 yr in float-charge service, the EHGS Exide-Ironclad costs considerably less per ampere hour per year than conventional Plante and flat-plate stationary batteries, according to Exide Industrial Div., The Electric Storage Battery Co. And because it stores more power in a given space and is more efficient for its weight, it is reported to save up to 64 per cent of floor and mounting-rack area and up to 55 per cent in weight.

The new battery incorporates a tubular-type positive plate design. The tubular plates, with Silvium grids, are described as 30 to 60 per cent thicker than those of batteries with flat pasted plates. Teamed with the new positive plates to deliver full power at high discharge are pasted negative plates that are 9 to 20 per cent thicker than usual. Assembled in a transparent polystyrene jar, the EHGS Exide-Ironclad comes in 10 sizes, with capacities at the 8-hr rate ranging from 200 to 800 amp-hr.



FUEL SAVINGS 16%



Longitudinal section of Union Type VO Steam Generator at City of Ames.

JOB: Includes delivering steam for a 12,650 KW Turbo-generator in Municipal Power Plant, City of Ames, Iowa.

STEAM GENERATOR: A Union Type VO Single-Pass (140,000 lbs./hr., 630 psi, 825° F). Fired by continuous ash discharge spreader stoker. Equipped with extended surface economizer for heat recovery. Selected for its adaptability to multi-fuel firing.

RESULTS: In continuous operation for six months, supplying total steam requirements, the Union VO was credited with fuel savings of 16%.

MORE INFORMATION: Many types and sizes of Union Steam Generators are described in illustrated Bulletin GB-959. Write: Union Iron Works, Erie, Pennsylvania.

UNION

steam generators

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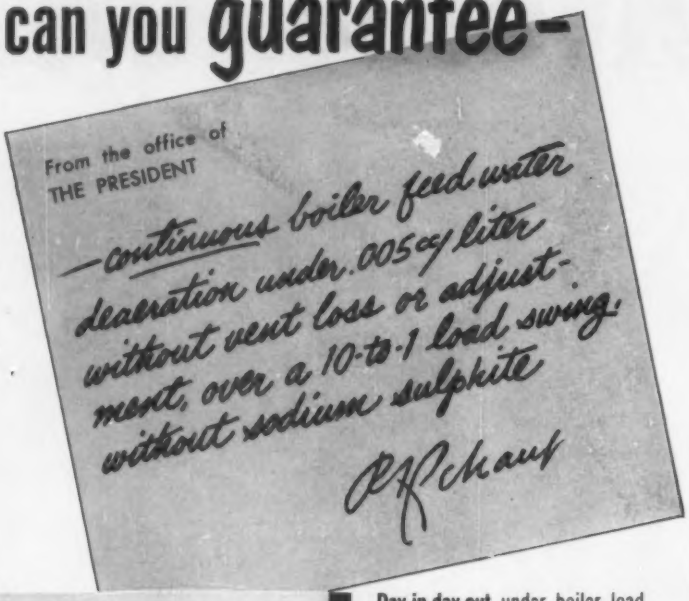
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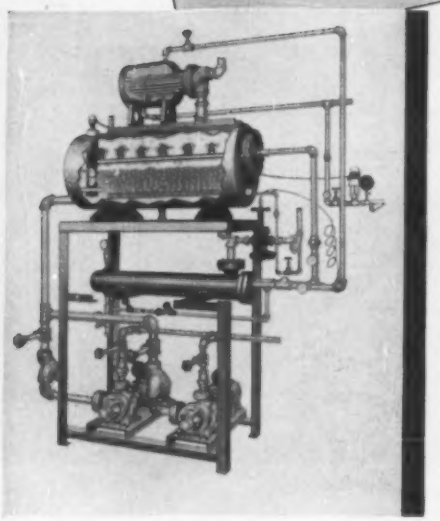

Day-in-day-out under boiler load swings as great as 10-to-1—**not** just under favorable fixed test conditions.

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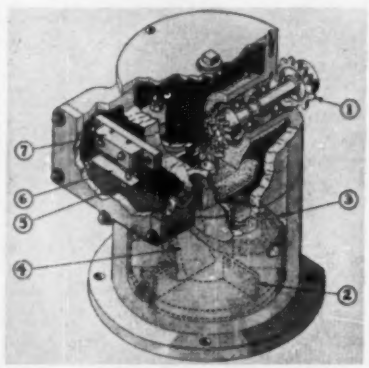
resin, and loosens silt. Iron, aluminum, carbonates and similar coatings react with chemical agents of the cleaner to form soluble complexes which are removed by backwashing and rinsing. At the same time caked resin is loosened and cleaned through removal of entrapped silt, and exchange capacity of fouled resin bed is restored. Cleaner comes in powder form, costs as little as 3 per cent of bed replacement price.

17—Motion safety switch prevents damage from stoppages

Reported especially useful for stopping a machine serving another, this switch may be used to control a motor circuit or operate a warning device. According to manufacturer, Fuller Co., this switch limits repairs to those necessary to correct the cause of stoppage. It is designed to be driven by any machine or equipment for which the continuous operation is essential to the safety and proper operation of related equipment or processes. It is under 10 in. in height and width, can be driven in either direction at 40 or 100 rpm.

A sprocket (1) on the drive shaft is connected by chain drive to a driven



shaft of the protected equipment. Through a pair of bevel gears, a horizontal paddle wheel (2) revolves in a body of oil (3) within the switch when operation is normal. Movement of the liquid tilts a vane (4) secured to a horizontal shaft (5), the end of which is half round to provide a flat surface. This surface becomes horizontal when the vane hangs vertically in the idle position. A hinged leaf (6) resting on the flat surface of the shaft is tilted by the half-round cam surface with the tilting of the vane. Movement of the leaf, caused when the vane falls to idle position, actuates a switch (7) to open or close a circuit.

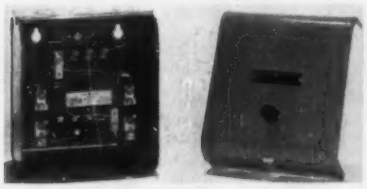
18—Transmitting rotameter needs no extension

Introduced by Fischer & Porter Co., the Magnarator combines functions of an indicating rotameter and a pneumatic transmitter. It measures liquid or gas flows and is claimed accurate to within 1 per cent over its 10 to 1 range. Flow travels vertically upward through metering tube which has no recessed or stagnant areas, company points out, making it ideal for all fluids. Float in metering tube is magnetically coupled to a rotating follower in pneumatic transmitter for positive continuous bond. Dual reading 4-in. vertical output scale indicates flow rate and transmitted

pneumatic signal which is linear. Horizontal reading scale shows float position independently of air supply and transmitter output. Single model transmitter can be used with any metering tube of ½- to 2-in. diam. covering flows equivalent to 1 to 100 gpm water and 4 to 400 scfm air.

19—Magnetic starters, contactors for low-horsepower uses

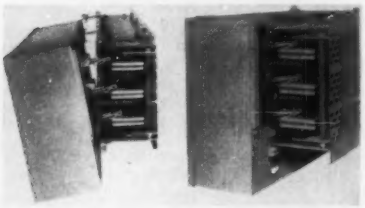
Size 00 magnetic contactors and starters for low-horsepower light duty applications have been added to the 100 line of



General Electric Co. For controlling conveyors, small pumps and fans, the Size 00 starter is said to offer about an 18 per cent price saving over the Size 0 starter which might have been used previously for such applications. Starters and contactors are designed for easier installation, less maintenance, and straight-out-the-front disassembly. Available for 115 or 230 v, the Size 00 units are single, two or three phase with ratings from ⅓ to 2 hp.

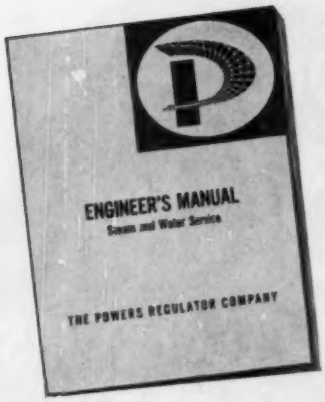
20—Hair-pin stab for use with low impedance plug-in bus duct

An inverted hairpin design that exerts more than normal pressure when carrying heavy inrush or short circuit currents is the feature of a stab introduced by Federal Pacific Electric Co. for use with take-off devices in low-impedance plug-in bus duct. It is shown prior to complete insertion (left) and in place (right).



The stab is designed to provide a normal contact pressure of 2000 psi. Since current travels around the hair-pin shape of the stab, heavy inrush current (such as required by large welders) causes magnetic forces around the two prongs of the stab which tend to separate them. One side is forced against the bus bar and the other against a leaf spring which is coil spring loaded. Tests are reported to show this stab will remain in contact with bus bar under inrush currents in excess of 35,000 amp.

Rated to carry 400 amp continuously, this stab can be installed in safety switches, circuit breakers, plug-in cable tap boxes, and panelboards when mounted directly on the duct. It's made in one size. On a three-phase system, three are used in each current take-off device. When a neutral is involved, four are required. The bus duct they are used with can be installed near the ceiling or in a dry floor trench, or verti-



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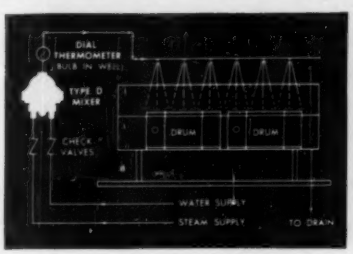

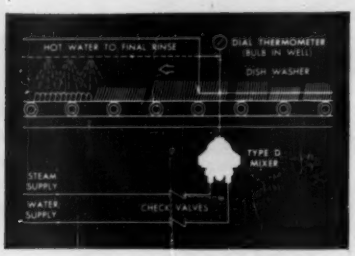

Schematics above show the function of Powers Type D Mixer in standard systems for maintaining uniform process hot water temperature where it is not practical to install or use a steam heated storage tank. These drawings are taken from the Powers *Engineer's Manual, Steam-Water Service* which is free to you for the asking. Each drawing is supplemented with detailed engineering information about the controls used. Everyone concerned with the installation and/or operation of steam-water service will find these diagrams a helpful guide in laying out a new system or updating an existing one. Other sections offer similar easy-to-follow diagrams and concise details on the following:

- Domestic Hot Water
- Hot Water Storage Heaters
- Instantaneous Heat Exchangers
- Heat Exchangers For Cooling
- Fuel Oil Heaters
- Pressure Reducing
- Jacket Water Cooling
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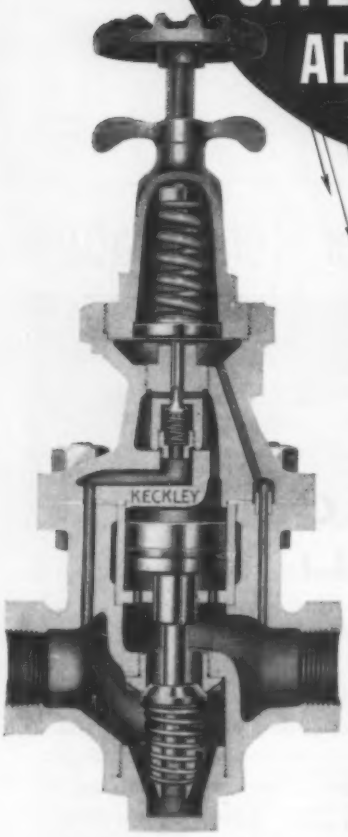

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cally in stair wells and wiring shafts. Dependable operation under heavy loads is said to make these stabs particularly adaptable for vertical riser application in commercial and institutional buildings, where maintenance is less frequent than in an industrial plant.

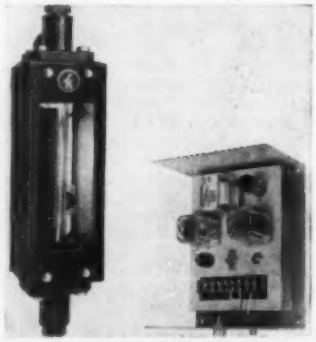
21—Segment bender is portable, one-man operated

No. 777, a lightweight segment bender for 1¼- to 4-in. aluminum or steel conduit and pipe, weighs 65 lb, exclusive of shoes. It is possible, with optional parts, to do 90-deg one-shot bending ½ to 2 in.,

and thin-wall (EMT) bending ¾ to 2 in., according to Greenlee Tool Co. The bender is powered by a two-speed, 10,000 psi hand pump, and can be operated with a power pump for faster operation. The ram develops 27 tons of pressure, and is designed to bend extra-heavy schedule 80 pipe. Features include: one-piece frame of high-strength aluminum, one set of aluminum pipe supports for all pipe sizes, and quick-locking pipe support pins.

22—Alarm rotameter features manual or automatic reset

Designed by Schutte and Koerting Co. to measure fluid rate of flow and indicate abnormal high or low flows by electronic detection, Series 18200-C Rotameters use a standard rotameter with 5-in., 10-in. or 600-mm tube, and high frequency pick-up sensing coil



mounted flush against the metering tube. This coil is connected by cable to the electronic alarm. The instruments are made to activate a warning light or alarm device, and to start, or stop a pump, motor, or control unit.

Model E, which requires manual reset, can be used with two sensing coils for high or low alarm settings. The float

is outside the field of the coil during normal flow conditions. When the float enters and interrupts the pickup coil field, the sensitive relay drops out and de-energizes the coil in the power relay, thus completing the alarm circuit — which remains closed until the float returns to its normal operating position and the power relay is reset by the reset button. Model EV, with automatic reset, is used with one coil to detect deviations above and below a desired flow condition. The float is within the coil field during normal flow conditions. Bulletin 18A gives specifications.

23—Combustion catalyst steps up boiler efficiency

Fireside Treatment 1 is announced by Dearborn Chemical Co. for use in coal fired boilers to improve fuel combustion, minimize slag build-up and assure steam production efficiency. It is a gray, free-flowing powder that can be fed by hand on the fire bed, added to the coal skip before dumping into the coal hopper, or fed by steam injector to prevent slag on grates, tubes and walls.

24—Web belt slings are woven of nylon or Dacron

These slings, developed by the Wire Rope Div. of Jones & Laughlin Steel Corp., come in a variety of sizes and capacities, in five nylon and five Dacron types and with a selection of fittings. According to company, 80 per cent of the slings' reserve strength is concentrated in the inner plies, which are protected from abrasion by two tough outer plies. Light in weight, unaffected by mildew, rot, bacteria or water, the woven slings have excellent handling properties at low temperatures, manufacturer notes, and provide safe duty up to 8-10 per cent elongation.

Available optionally is a Neoprene coating claimed to increase abrasion resistance by 50 per cent and increase coefficient of friction to a minimum of 2½ times that of other impregnating materials. This coating is reported particularly advantageous when handling objects with polished or slippery surfaces. Nylon slings come in nine standard widths from 1 to 12 in.; Dacron slings, in six widths from 1 to 6 in.

25—Foamed plastic for use as load bearing insulation

Rigid Armaflex, a product of Armstrong Cork Co., is a rigid plastic material for use as load bearing insulation at pipe hanger locations, deeply buried under-

RETURN LINE CORROSION *Can* BE LICKED!

Drastic reduction of return line corrosion in an easy, effective and economical way has been the unanimous experience of hundreds of plants throughout the country using Bird-Archer's Amine Treatment.

A plant in New York State, generating approximately 500,000 lb. of steam a day, had a normal condensate pH value of 6.3 that resulted in almost constant piping replacements. Only 6 lb. per day of Bird-Archer's Amine Treatment cut maintenance costs to a new low by raising the pH value to the safe range of 8.0 to 8.5.

A plant in New England, generating 600,000 lb. of steam a day, did not have an open feedwater heater which would mechanically eliminate the exceedingly high CO_2 content of their makeup water, consequently, the pH value of their condensate was sometimes as low as 5.9. Less than 12 lb. of Amine Treatment a day raises the pH value of the condensate to 8.5, eliminates excessive corrosion.

After two years of experience with Amine Treatment a power plant in Massachusetts, making 250,000 lb. of steam a day, enthusiastically reports that they eliminate over 75% of their piping replacements through the use of only 2 or 3 lb. a day of Amine Treatment.

Return line corrosion has been licked at these plants. Let a Bird-Archer Service Engineer help you solve *your* corrosion problems.

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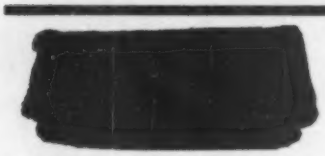

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ground lines, and other areas where pipe covering may be subject to compression set deformation. With properties similar to Armaflex 22, a flexible foamed plastic pipe covering, Rigid Armaflex was developed to be used in conjunction with the flexible material. It comes in ½- and ¾-in. thicknesses for sizes ⅜ in. ID to 3 in. IPS, and is furnished in half sections 3 ft long.

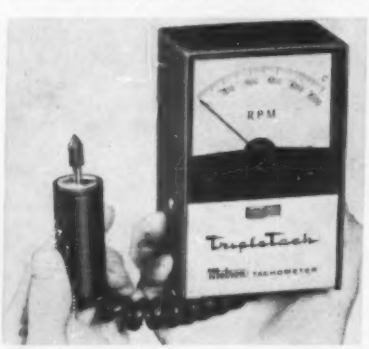
26—High pressure shutoff valve with full flow passage

Announced by Circle Seal Products Co. as an addition to its 900 Series is a leakproof high pressure shutoff valve featuring full flow passage and O-ring sealing. It is of right angle configuration for mounting convenience. The R900 Valve has a single inlet and outlet; the Y900

has a single inlet and two outlets; the Z900, two inlets and a single outlet. Basic stainless steel construction, coupled with a choice of O-ring materials, permits use of this valve with most gaseous or liquid service media. Buna N, Neoprene or Viton A O-rings are available. Operating temperatures range from −40 to 450 F; operating pressures from 0 to 6000 psi. Burst pressure is given as over 20,000 psi. Stem and seat are designed to permit gradual throttling of flow as valve is actuated, it is pointed out, and only 20-in lb of force is required to actuate valve under full 6000 psi pressure.

27—Hand tachometer is small in size, low in price

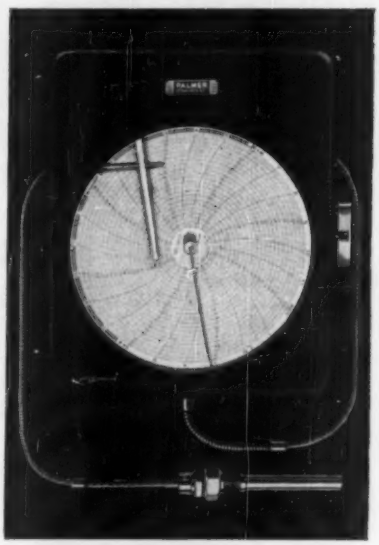
As announced by Metron Instrument Co., features offered by the Tripletach include small size, light weight, rugged construction and a price tag under $100. The metal case contains sealed meter movement, printed circuitry, speed pick-up and its retractible cord, and provides storage space for shaft tips and



PALMER

MERCURY ACTUATED RECORDERS

Into this modern Mercury Actuated Recorder has gone all the skill of Palmer Master Craftsmen



Readings are clearer, smoother and more precise than ever thought possible. In fact readings are so amazingly improved that maintenance is never needed under normal uses.

Recording Thermometers feature twelve inch die-cast aluminum case with black wrinkle or white satin finish. Single or multiple pen construction. Electric or spring wound clock, 24 hour or 7 Day Revolution. Flexible Armor and bulb of stainless steel. Ranges: —40 to 1000°F. or Equivalent in °C.

Send for Bulletin No. 45
Consult your Classified Directory

PALMER

PALMER THERMOMETERS, INC.
Mfrs. of Industrial Laboratory, Recording and Dial Thermometers
Cincinnati 12, Ohio

For more data circle 559 on Post Card

other accessories. Series 27 Tripletach is available in three types; Type A measures from 200 to 10,000 rpm; Type B, from 100 to 5000 rpm; and Type C, from 20 to 1000 rpm.

28—Split-body valves "mix and match" with others

Split-body valves introduced by Minneapolis-Honeywell Regulator Co. are interchangeable on a "mix and match" basis with company's other valves and actuators. Available in straight-through, angle and corner types with fixed or separable flange construction, valves are designed for free passage of even highly viscous fluids.

29—Wall mounted chlorinator of simplified design

Feature of Fischer & Porter Co.'s 3600 Series Chlorinator is the safety stack regulator within which all control components are housed. This reduces frail piping and connections — potential leak sources. The design also incorporates a

shut-off valve, sealing the chlorine supply from the chlorinator during inoperative periods; an isolating valve which serves to seal tight the functional parts of the safety stack; and a differential pressure regulator to maintain stable chlorine gas feed. The manually operated unit is designed to maintain an accuracy of ±2 per cent of feed rate over a 20-to-1 range in flow. A snap-in flowmeter tube allows capacity changes from 3 to 200 lb of chlorine gas per day.

30—Control centers redesigned for longer service life

Available with bus ratings from 600 to 1600 amp and voltage ratings from 110 to 600 v, these redesigned motor control centers of Allis-Chalmers Mfg. Co. are announced as offering longer service, greater versatility and easier maintenance. Horizontal buswork can be installed at top or bottom of the 20-in. wide by 20-in. deep motor control centers. Vertical buswork is braced for 50,000 rms (interrupting capacity) compared with the former 25,000 rms.

The six vertical bus supports are nonbreakable, glass-filled polyester and curve molded to eliminate dust catchers. Vertical wiring troughs have been expanded and conduit openings are 14 by 14 in. for greater flexibility. Split covers afford easier access to the openings. A plug-in terminal block is now standard and pushbuttons are now on the pan with pilot lights. The control centers are

SAFE & SILENT PROTECTION

Like many other prominent new buildings throughout the country, the heating, piping and air conditioning systems of the new Signal Oil and Gas Company's 16-story home office building in Los Angeles are fully protected from surge pressures and resulting water hammer damage with Williams-Hager Silent Check Valves.

Architect—Charles Luckman Associates
General Contractor—C. L. Peck
Heating and Air Conditioning Contractors—Western Air & Refrigeration, Inc.
Piping—Lohman Bros.

WILLIAMS-HAGER
Silent
CHECK VALVES

For complete information write for Bulletins No. 654 on Silent Check Valves . . . No. 659 on Pressure Loss Tests . . . No. 851 on Cause, Effect and Control of Water Hammer.

THE WILLIAMS GAUGE CO., INC.
143 Stanwix Street, 2 Gateway Center
Pittsburgh 22, Pa.
Our 74th Year • 1886-1960

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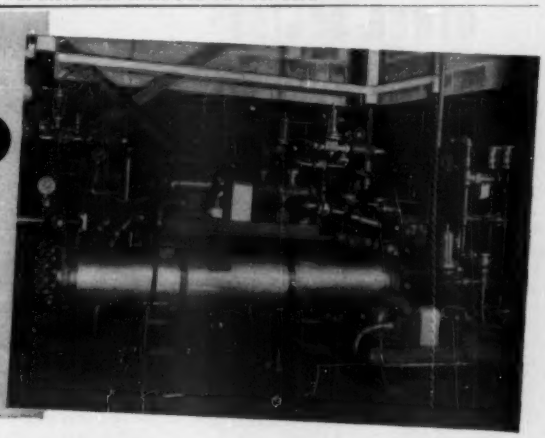
2 ENCO FUEL OIL UNITS in this plant



Here is a typical 2 unit installation of Enco fuel oil pump sets—selected to take care of all the requirements of a building materials manufacturer.

The Large Unit has 2 pumps and 2 heaters, completely automatic and arranged for operation with either heater, or either pump—or both. With one heater and pump the capacity is 11 gpm Bunker C oil at 300 psig pressure, and temperature rise from 90F to 230F.

The Small Unit is for cold starting up—has no heater. The capacity is 3 gpm of No. 2 oil at 300 psig pressure.

All Enco sets are individually designed, each for specific plant conditions—for easy installation, low maintenance and minimum carefree operation.

Complete details including the 10 important features of Enco fuel oil heating and pumping sets are given in Bulletin OB53. Copies gladly sent upon request.

THE ENGINEER COMPANY, 75 West Street, New York 6, N. Y.
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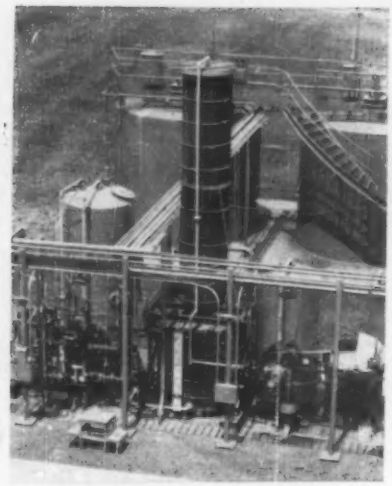
ILLCO-WAY

ionXchange



"SILICA: 0.003 PPM, OTHER SOLIDS UNMEASURABLE..."

With some doubt as to the outcome, the de-ionization units pictured above were installed outdoors at a Texas power and light company, to replace evaporation equipment as a means of purifying feed water for a high-pressure boiler. After three years, results far exceeded guarantee and expectations. From raw water containing 27 ppm of silica and dissolved solids totaling 365 ppm, the quality of the effluent is reported as: "Silica, zero to 0.005 ppm, average 0.003 ppm. Other solids are unmeasurable."—This is a good example of what modern ILLCO-WAY ionXchange can accomplish.

BOILER FEED WATER FOR POWER PLANT

The particular plant shown above consists of a cation exchanger, an aerator, and a mixed-bed deionizer. The large tanks in the background hold a supply of regenerants. Operation is manual throughout, a preference of the purchaser. *Results have proved even more economical than expected.*

ionXchange

ILLINOIS WATER TREATMENT CO.

ILLCO-WAY

840 CEDAR ST.
ROCKFORD,
ILLINOIS

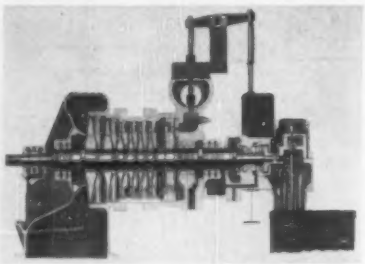
NEW YORK OFFICE: 141 E. 44th St., New York 17, N.Y.
CANADIAN DIST.: Pumps & Softeners, Ltd., London, Ont.

For more data circle 562 on Post Card

available with steel or aluminum frames, pans and other major structural parts in NEMA 1 gasketed, 12 or three non-walk-in and walk-in enclosures.

31—Small turbines are high-speed multistage units

The line of small turbines manufactured by Westinghouse Electric Corp. has been extended to include high-speed multistage units, in five frame sizes,



rated 32,000 hp and 16,000 rpm. All sizes are designed for maximum steam conditions of 1500 psig and 950 F, but conditions to 2400 psig and 1050 F can be accommodated for special applications. Turbines can be built with as many stages as are needed, with any of five wheel diameters from 12 to 32 in.

32—Safety chain protects men and equipment too

Designed by Kayto Mfg. Corp. to protect men working above ground from falls, and guard those below against falling tools and equipment, this chain is

simple in design and operation. It features a safeguard toggle clamp with a 1-ton grip which fastens to any object up to 1¾ in. thick. On the other end of the 4-ft, 500-lb test chain is a fast-snub clip for snapping to safety belts, tools.

33—Low cost transmitters with optional servo power

210T and 211T Transcope Transmitters, Taylor Instrument Companies, are designed to provide an input-to-output accuracy of ½ per cent in the measurement of gage pressure, volumetric pressure, temperature, and volumetric load. They feature a sealed cartridge servo unit to maintain this high transmission accuracy under load. Typical loading arrangements might be in the use of auxiliary process alarms, or encoder takeoffs, which would impose a load on the pointer system. According to manufacturer, low friction in the sealed

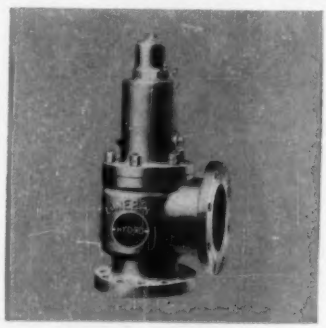
THE LONERGAN LINE

HOW TO SAVE WEAR AND TEAR ON MEN AND VALVES

by A. J. Schmidt, Chief Engineer

Power plant users of relief valves in liquid service are undoubtedly all too familiar with chattering. Valves hammer away, annoying plant personnel and running up maintenance bills.

Even with this undesirable operation, these



valves have been acceptable for application where the valves are seldom, if ever, called upon to relieve. For use under critical applications, such as pump-by-pass, where the valve is normally open, or where opening is a common occurrence, it has been necessary to use expensive diaphragm or piston operated valves to eliminate objectionable chattering.

A new series of valves, called Lonergan Hydro-Valves have been under test in dozens of leading plants for the past three years. As a result, Lonergan can provide power plant operators with a valve that is guaranteed not to hammer, chatter or drum on any application, by-pass or emergency relief. At the same time, full-rated liquid flow is maintained. The chatter free operation is provided by a patented, unique design of throat, seat and baffle construction. Use of the Hydro-Valve helps to: save human nerves; prevent loss of plant fuel or product; reduce maintenance on valves and piping; and eliminate interference with delicate control systems. Hydro-Valves are available in all regular body and trim materials in sizes ranging from 1 to 8 inches.

Full details and descriptions are available in our new Hydro-Valve bulletin. Why not write for your copy today?

Alvin J. Schmidt

Lonergan

J. E. LONERGAN CO., 207 RACE STREET
PHILADELPHIA 6, PA. SINCE 1872

For more data circle 563 on Post Card

ndicator-driving mechanism permits a 0.1 per cent of input-span sensitivity to, and little deterioration of, low-energy input signals; an 11¾ in. scale, readable at 35 ft, provides an indication accuracy of 1 per cent of actual value of the variable being measured. The 3-15 psi transmitter output may be fed directly to other indicating, recording or controlling stations. Bulletin 98385 covers it.

34—Hydraulic acoustic filter eliminates liquid borne noises

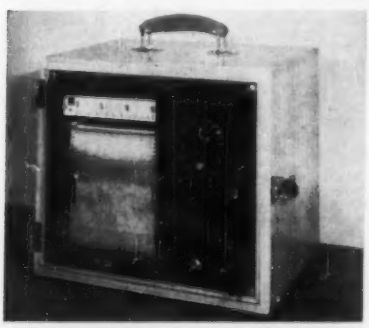
The Pulsco Acoustic Filter is introduced by Pulsation Controls Corp. to reduce liquid borne noises in hydraulic systems, water systems and electronic cooling systems. The units are applied on high pressure hydraulic systems for eliminat-

ing liquid borne noises from positive displacement pumps and on water systems for eliminating noises caused by centrifugal and turbine type pumps.

The acoustic low pass interference type filter utilizes a split flow principle to achieve attenuation and phase cancellation. The filter has removed as much as 21 decibels of noise energy, amounting to in excess of 99 per cent of noise in frequency ranges from 10 to 500 cps, manufacturer states. Units are designed in pressure rating to 8000 psig and sizes from 8-to 42-in diam. Bulletin 201A gives details.

35—Portable recorder covers 23 ranges, a-c and d-c

Model 802 Recorder is designed by Curtiss-Wright Corp. to cover 23 ranges, up to 15 amp and 600 v, a-c and d-c. A clamp-on transformer is available to increase the a-c range to 300 amp. A 50 mv connection is provided for shunts.



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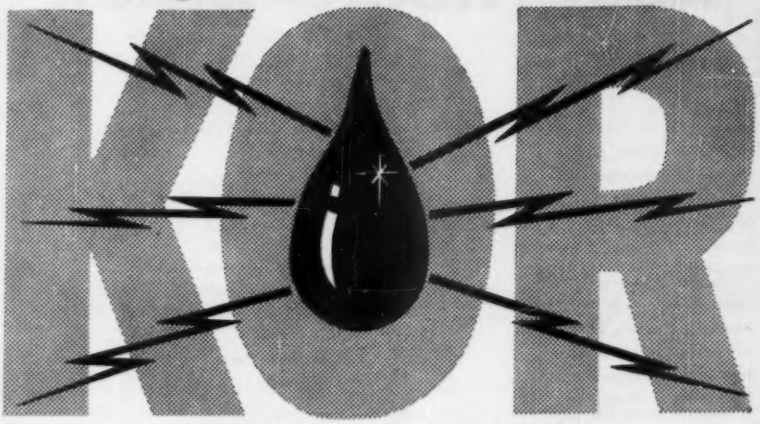
MEDINA

ELECTRIC COOPERATIVE, INC.

is receiving applications for Senior Operators, Control Operators, and Plant Electricians for employment in a new 66,000 KW Steam-Electric Generating Plant 50 miles south of San Antonio, Texas. Send complete resume to Medina Electric Cooperative, Inc., Box 1028, Pearsall, Texas.

Put more POWER in your fuel oil with



World's most powerful fuel oil additive!

- **KOR gets more power** from any kind of fuel oil: petroleum pitch, other residual oils, coal tar, diesel oil.
- **KOR dissolves sludge,** prevents it from forming, suspends it in solution for fast combustion!
- **KOR keeps systems clean** from tank to stack, eliminates soot and carbon scale, cuts cleaning costs. It's alkaline, non-corrosive!
- **KOR cuts fuel costs,** activates all the BTU's in both oil and sludge. Safe and easy to use. Write for literature today!

KOR CORPORATION 812 Box 485, Gary, Indiana

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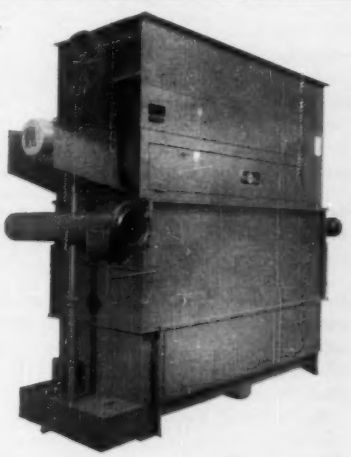
How to get drier or cooler AIR or GASES

at low cost



NIAGARA *AERO* AFTER COOLER cools a compressed gas, or air, below the temperature of the surrounding atmosphere, thus preventing the condensation of moisture in your lines. The gas will contain only half of the moisture left in it by conventional methods. Even drier gas can be produced if you require it.

In working with controlled atmospheres of inert gases to prevent undesired reactions, this dryness of the gas at low cost is a great advantage. The cost of the Niagara method is low because it uses evaporative cooling, saving 95% of the cost of cooling water (and its piping and pumping). This direct saving of cost pays for the Niagara cooler in less than two years.

If you use compressed air to operate instruments or pneumatic equipment you will get better results by using the Niagara Aero After Cooler.

Write for Bulletin 130, or ask nearest Niagara Engineer if you have a problem involving the industrial use of air.

NIAGARA BLOWER COMPANY

Dept. E-12, 405 Lexington Ave., New York 17, N. Y.

Niagara District Engineers in Principal Cities of U.S. and Canada

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1960 Annual Index

VOLUME LXIV

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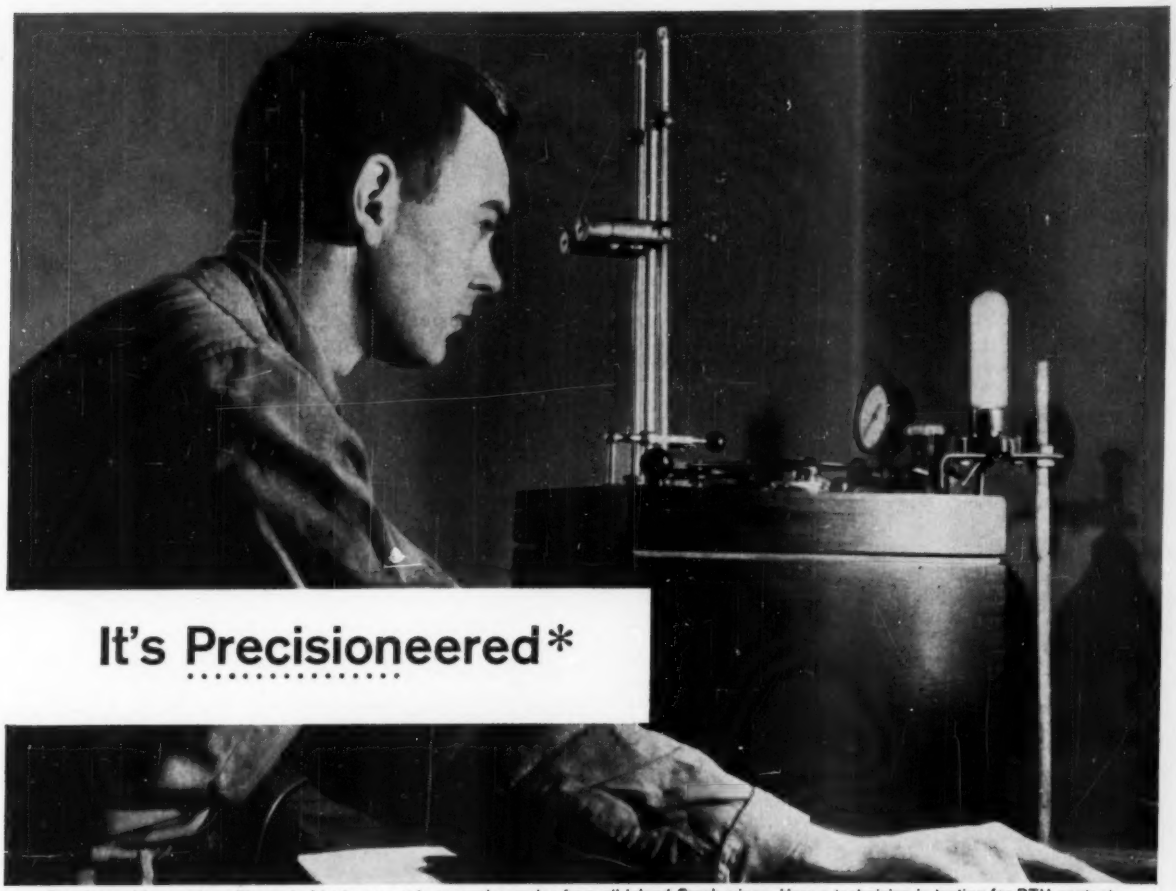

It's Precisioneered*

Regular and frequent quality control tests are made on coal samples from all Island Creek mines. Here a technician is testing for BTU content.

* PRECISIONEERING is a chain of controlled events that actually begins and ends at your burning equipment. It starts with the question: What kind of coal does your equipment require to produce steam at the lowest net cost per 1000 lbs.? It provides the answer, through penetrating engineering and evaluation studies. It produces the answer . . . with superior seams of coal prepared exactly to your determined specifications in modern preparation plants, using precision engineering techniques and strictest laboratory controls. We'd welcome a chance to discuss the possible reduction of your net costs through Precisioneering. Write. Or phone. No obligation, of course.

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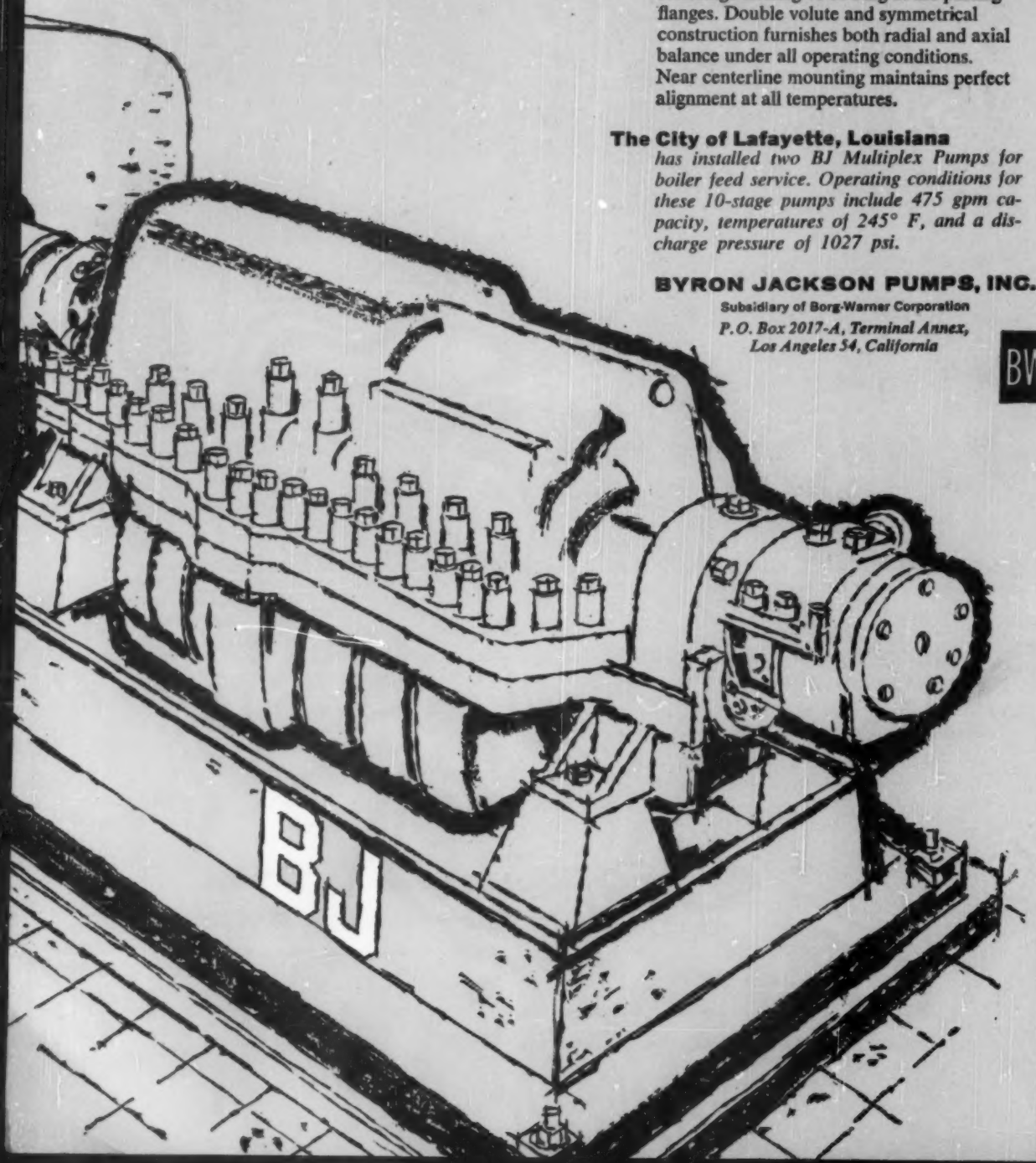
For high pressure, high temperature and high speed pumping, an extra safety factor is built into this DVMX Pump—*the safety of a quality product!*

Clean and compact, BJ's advanced design allows double-row bolting to prevent interstage leaking or bowing at the parting flanges. Double volute and symmetrical construction furnishes both radial and axial balance under all operating conditions. Near centerline mounting maintains perfect alignment at all temperatures.

The City of Lafayette, Louisiana

has installed two BJ Multiplex Pumps for boiler feed service. Operating conditions for these 10-stage pumps include 475 gpm capacity, temperatures of 245° F, and a discharge pressure of 1027 psi.



BYRON JACKSON PUMPS, INC.

Subsidiary of Borg-Warner Corporation

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